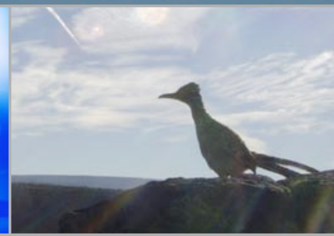
WATER RESOURCES PLAN

2005 UPDATE



City of Phoenix

WATER RESOURCES PLAN UPDATE 2005

Water Services Department | Water Resources and Development Planning Section

Adopted by Phoenix City Council March 8, 2006

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Original redwood water line from the Verde River to Phoenix (circa 1922)

INTRODUCTION

Downtown Phoenix

INTRODUCTION

PLAN OVERVIEW AND PURPOSE

This 2005 Update of the Phoenix Water Resources Plan provides guidance for water acquisition, water management and infrastructure actions necessary to ensure sustainable water availability for current customers and anticipated growth over the next 50 years. The Plan considers these needs under a variety of development scenarios and surface water shortage conditions.

WATER PLANNING GOAL

Develop and maintain sufficient sustainable high-quality water supplies and related infrastructure to meet current and future customer demands during both normal and drought conditions.

The Water Resources Plan is typically updated every five years to reflect updated water demand projections and water supply conditions. Prior plans have concluded that Phoenix's historic and anticipated water supplies were sufficient to meet the long term needs of current customers and a significant level of growth. Though the City maintains a sound and well-diversified portfolio of water supplies, the region's recent experience with relatively severe and lengthy drought conditions in its major source watersheds has reinforced the need to further assess Phoenix's vulnerability to long-term surface water shortages. In addition, Phoenix's growth patterns, and thus water demand, may be significantly affected by changing economic or demographic trends. For these reasons, the City's 2005 Water Resources Plan Update concentrates on these key uncertainties and identifies relevant strategies to more effectively prepare the City for what may lie ahead.

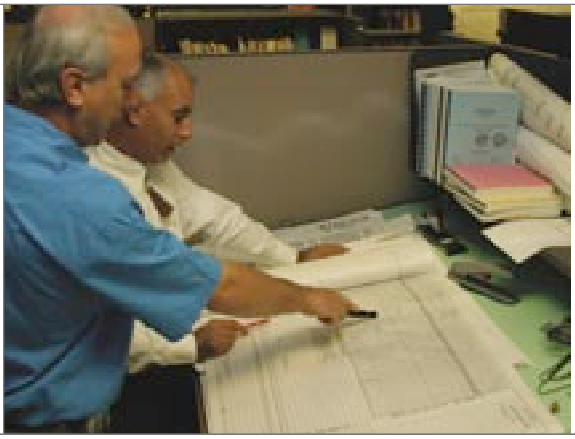
This 2005 Water Resources Plan Update concludes that Phoenix's well-diversified portfolio and integrated water system is capable of handling a wide variety of growth and drought scenarios. However, expected growth pressures will dictate significant capital expenditures to "drought-proof" the portfolio and to develop treatment and transmission systems to allow for deployment of available water supplies. This plan provides a foundation for the magnitude and timing of water development projects, and provides a basis for revenue generation alternatives. It also sets the stage for a more thorough process which will include the development of several "functional plans" addressing groundwater management, recharge, water reuse, conservation, drought response and other key portfolio management considerations.

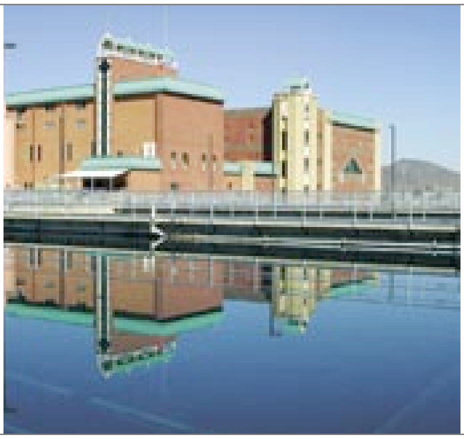
A key objective of this Plan is to determine the optimal level of water supply and infrastructure redundancy to maintain sufficient deliveries to the City's growing population under a variety of conditions. The Plan also provides general guidance for capital program planning, and serves as a basis for the Water Resources Acquisition Fee (a one-time charge for newly developed lots which helps to offset the City's water acquisition costs).

Phoenix has been facing the challenges of growth and drought for decades. Foresight in acquiring water supplies, developing necessary infrastructure and establishing water conservation standards has prepared the City for the dry conditions experienced in the past several years. Because the water resource planning process is iterative by nature, the City will continually reevaluate conditions and adapt our strategies accordingly to maintain a reliable water supply for customers during both normal and drought conditions.

Concurrent with the development of this Plan, the City is updating its Water System Master Plan and Wastewater System Master Plan. These two efforts focus more specifically on the detailed infrastructure needed to meet the capacity requirements of both the water distribution system and the wastewater collection system as the City grows. These efforts have been developed in concert with this Water Resources Plan to ensure uniformity of growth and water demand assumptions.

The first three chapters of this 2005 Update describe the regional water planning environment, Phoenix's current water supply portfolio and the City's water demand characteristics. Chapters 4 and 5 present a number of scenarios incorporating varying growth and drought levels, and advance key strategic concepts to guide decision making. The final chapter describes the functional plans and specific water supply and demand management strategies which may be considered in detailed planning and implementation efforts over the next several years.





CHAPTER 1:
THE REGIONAL CONTEXT

THE REGIONAL CONTEXT

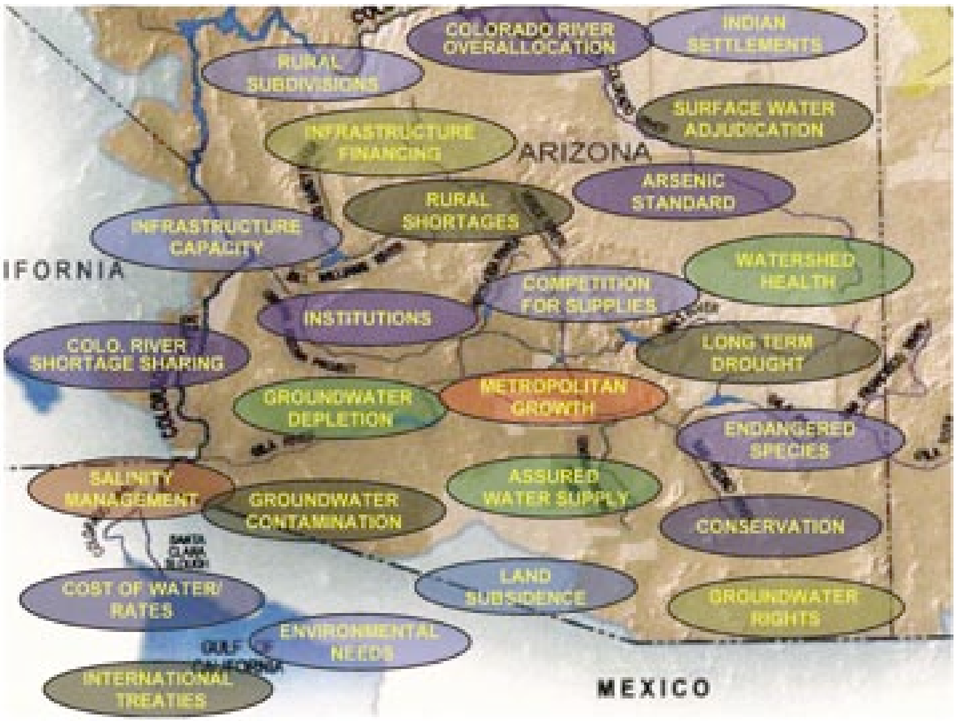
Hedgehog

Phoenix's Sonoran Desert setting, with an average precipitation of less than 8 inches per year, is often characterized as being in a perpetual state of drought. The chronology of human activity in this area, from the days of the Hohokam, is invariably tied to the development of water resources.

The vibrant economy and the high quality of life enjoyed by Phoenix residents today is heavily rooted in the large-scale water storage and distribution projects which service the region. The Central Arizona Project (CAP) and Salt River Project (SRP), along with associated reservoirs, are the product of foresight, dedication and leadership of prior generations which recognized the fragile nature of human settlements when left to the natural cycles of the desert.

A complex and dynamic array of laws, regulations, policies and institutional structures are as much a part of today's water management landscape as the engineering features and hydrologic conditions.

Phoenix's water resources are affected by a wide variety of other influences within the region, the state and the southwest. Issues and uncertainties regarding growth, drought planning, Colorado River operations, water quality standards, aquifer management, the Endangered Species Act (ESA), water recycling, water importation, desalination, climate variability and numerous other factors contribute to an extremely dynamic environment in which water planning decisions are made. This section will briefly discuss some of the key features of Phoenix's water planning environment.



REGIONAL SETTING

With an estimated 2005 population of more than 1.4 million, Phoenix represents approximately 40 percent of the Maricopa County total of 3.5 million residents, and approximately 25 percent of the State's 5.7 million residents. The $140 billion per year Phoenix area economy[1] is represented by a diverse range of industries and predominantly thrives on growth.

Phoenix serves an incorporated area of 546 square miles. This includes approximately 39 square miles annexed since 2000. The water system also serves a portion of the Town of Paradise Valley and provides treatment services to other entities on a limited basis. Surrounding municipalities typically rely on the same source watersheds, though each entity maintains independent water supplies, water utilities and distribution systems (Figure 1-1). Each utility maintains its own unique water resources portfolio.

Growth and development within the greater Phoenix metropolitan area, which covers much of Maricopa County, the northern portions of Pinal County and southern portions of Yavapai County, may impact water demand within Phoenix. Significant expansion of the urban area is evident with the emergence of large master planned communities from Surprise and Buckeye to Queen Creek. As these surrounding communities grow, the importance of Phoenix as the commercial hub of the region may influence the water demands within the City. For example, the City's residential water demands may not grow at the same rate as non-residential water demands due to higher densities within Phoenix and/or due to the expansion of the suburban "bedroom" communities.

The interrelationships between Phoenix area municipalities and Arizona's Indian Communities also add to the complexity of the local water planning landscape. Phoenix is a party to several Indian water rights settlement agreements, and maintains long term leases of tribal CAP water for a portion of the City's overall supply. The most recent settlement, with the Gila River Indian Community (GRIC), was authorized as a part of the Arizona Water Settlements Act signed by President Bush in December 2004.

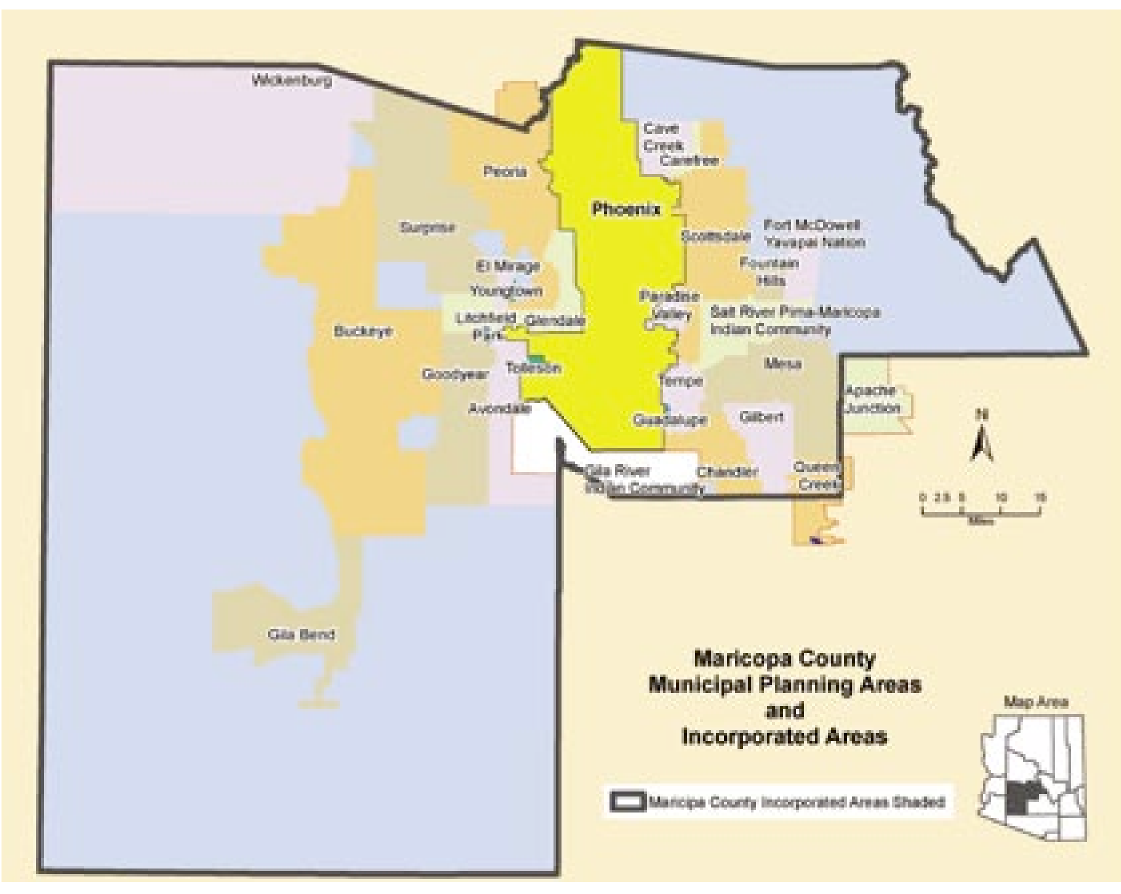


Figure 1-1. Maricopa Cities and Towns

[1]*Global Insight (2006) The Role of Metro Areas in the US Economy – Prepared for the US Conference of Mayors, p 12*

WATER SOURCE SUMMARY

Phoenix relies on four primary water supply sources. The availability of each water supply is governed by unique hydrologic, legal and institutional factors. Surface water is generated from two different watershed areas. SRP supplies water from the Salt and Verde rivers to eligible lands within the Phoenix service area which are generally south of the Arizona Canal (Figure 1-2). The remainder of the service area is supplied primarily by Colorado River water delivered by the CAP. Groundwater wells and reclaimed water make up the remainder of the City's water supplies.

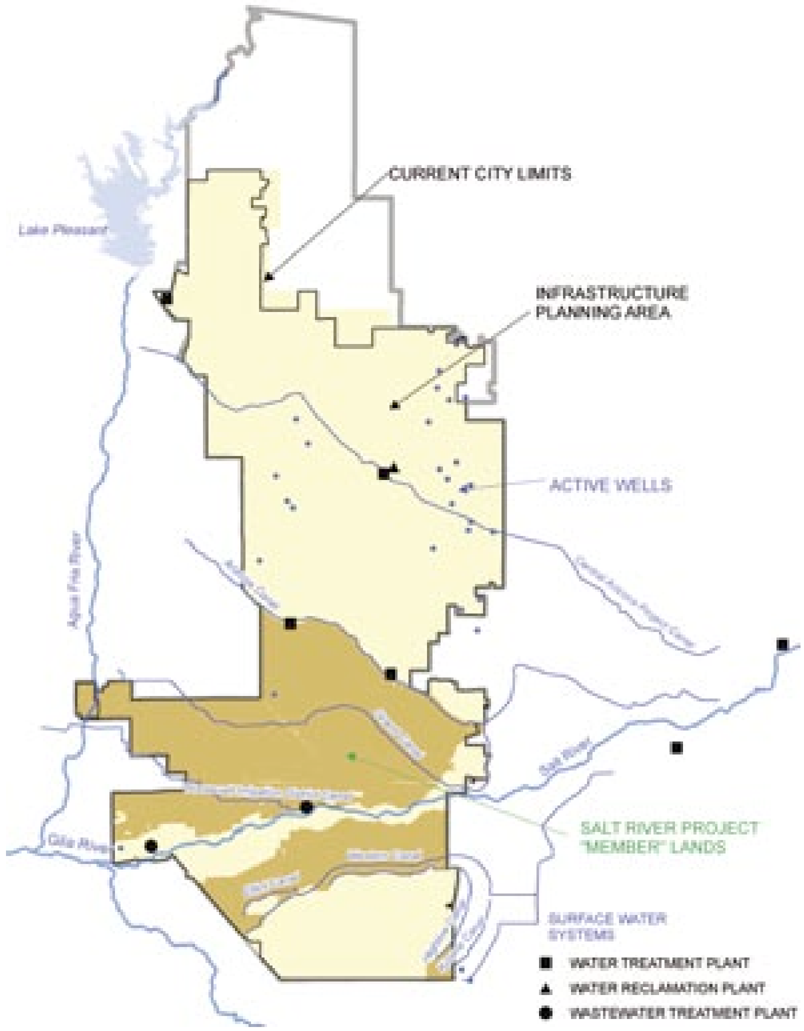


Figure 1-2. Phoenix Water Planning Features

The pressures on these water sources are escalating due to continuing growth in the Phoenix metropolitan area, in rural Arizona and throughout the southwest. As an example, the low-flow conditions in the Colorado River Basin over the past several years have triggered more intense negotiations among the seven Colorado River Basin states to seek mutually beneficial reservoir operating agreements and equitable shortage criteria. At the same time, the U.S. Department of the Interior is moving forward with a process to address these same issues. As one of Arizona's largest CAP subcontractors, the City of Phoenix has participated in this important dialogue.

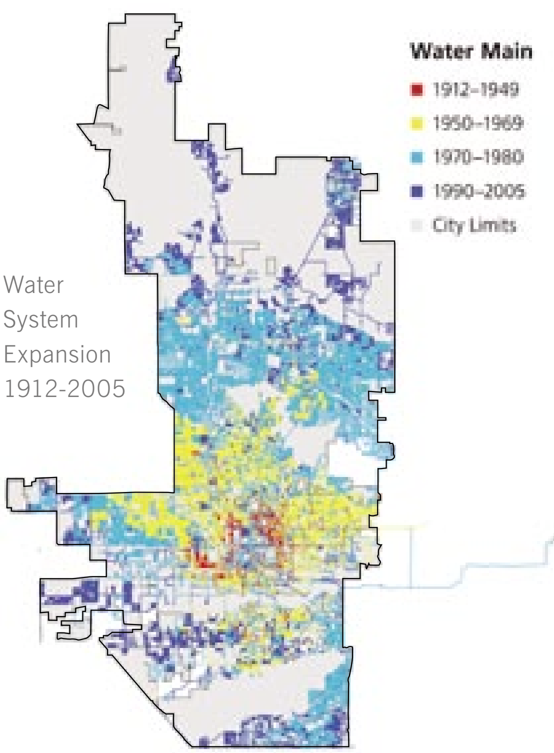
Phoenix's water sources are described in more detail in Chapter 2.

AN OVERVIEW OF THE PHOENIX WATER SYSTEM

The initial water system acquired by Phoenix in 1907 utilized groundwater obtained from shallow wells. The relatively brackish and poor-tasting condition of this water led to the tapping and delivery of higher quality water from the Verde River, about 30 miles east of town. The water was delivered through a redwood pipeline which was replaced by a larger capacity concrete pipe in 1931. In the 1940s, deeper wells were drilled about 12 miles east of town.

Today, the Phoenix Water Services Department meets the needs of a service area that currently covers more than 500 square miles. Major features of the current potable water system include five surface water treatment plants and a network of groundwater wells (Figure 1-2).

Surface Water Treatment Plants | In 1947, the City's first surface water treatment plant was completed on the Verde River to utilize surface water. As the system grew with the acquisition of several private water companies, it became clear that additional surface water treatment plants were needed. Thus, the City entered into the 1952 Water Delivery and Use Agreement with SRP which provided for deliveries of water (that formerly went to farm land within the City) to treatment plants. As a result, three additional surface water treatment plants were built between 1952 and 1975, all on the SRP canal system. The 24th Street, Deer Valley and Val Vista Plants treat and deliver water primarily to urbanized lands with rights to SRP supplies. The agreement, which was revised and updated in 2002, also allows the City to access untreated canal water for irrigation of City parks and golf courses.



Water System Expansion 1912-2005

In 1986, the City completed the Union Hills Water Treatment Plant on the newly constructed CAP canal. The City is in the process of constructing an additional CAP plant at Lake Pleasant for service to the northern portion of the system. Another plant on SRP's Western Canal (in the southern portion of the City) is proposed for construction in the next 10 years. This plant will predominantly serve "on-project" areas (those within the SRP boundaries).

In 1990, an interconnect facility was built at the Granite Reef Diversion Dam where the CAP and SRP canal systems intersect. This facility allows CAP water to be sent to Phoenix's water treatment plants on the SRP system (through SRP canals) under both normal and drought conditions. This feature significantly increases the reliability of Phoenix water supplies.

Groundwater Wells | The City has developed or acquired more than 200 groundwater production wells through the years. However, a majority of these wells have been removed from service due to age, reduced efficiency and/or degraded water quality due to groundwater contamination. There are approximately 30 active wells currently in production that can generate 67 million gallons of water per day (mgd). Five of these wells were drilled and equipped since 1998. The actual number of wells available at any given time varies. Planning for the expansion of the well network is currently underway to assist in meeting future peak demand needs to provide operational flexibility and redundancy and to accommodate surface water shortfalls during anticipated drought conditions.

Total System Capacity | The five treatment plants and active well network have a total production capacity of 697 mgd (Table 1-1). The plants, wells, and more than 6,000 miles of water mains are designed to meet the maximum day water demands that occur during the summer months. Other facilities, such as reservoirs, booster stations, and pressure reducing valves are designed in synergy to meet "maximum day peak hour demands" and to provide emergency capacity when treatment plants or distribution components are restricted. Large transmission mains provide substantial ability to move water throughout the interconnected system, thus providing a high degree of redundancy under foreseeable conditions.

TABLE 1-1 MAJOR WATER PRODUCTION FEATURES | Potable System

FACILITY	EXPANSION YEAR	CURRENT CAPACITY (MGD)	ANTICIPATED EXPANSION (MGD)	TOTAL (MGD)
Verde		50	-	50
Val Vista[1]	-	130	-	130
Deer Valley	-	150	-	150
24th Street	-	140	-	140
Union Hills	-	160	-	160
Lake Pleasant[2]	2007	0	80	
	2015–2040	0	240	320
Western Canal[3]	2015	0	40	
	2025	0	80	120
Wells[4]	2006–2025	67	?	67
TOTAL		**697**	**440**	**1,137**

[1] City of Phoenix share (The City of Mesa maintains the remaining capacity)
[2] First phase currently under construction
[3] Proposed
[4] Well capacity expansion to be addressed in the City's upcoming "Groundwater Management Plan"

Val Vista Water Treatment Plant | Solids Handling Facility

Agreements with other Entities | The Phoenix system provides water to other systems under a variety of service agreements. The largest of these is with the City of Mesa, whereby Phoenix shares 41 percent of the Val Vista Treatment Plant capacity with Mesa. Phoenix also maintains wholesale agreements with Scottsdale, Tolleson, and the Salt River Pima Maricopa Indian Community (SRPMIC). In addition, the City maintains a wholesale agreement with Arizona American Water Company to provide potable supplies to Phoenix customers within the incorporated portion of the Anthem development east of Interstate 17 (I-17). A transmission line to the area, completed in 2005, provides Arizona American an emergency backup supply for its system which largely serves the County portion of the development west of I-17.

Reclaimed Water System | To conserve drinking water supplies, Phoenix is pursuing the full utilization of reclaimed water. In 2000, the City began delivering reclaimed water from the 8 mgd Cave Creek Water Reclamation Plant (CWWRP) to turf facilities in northeast Phoenix. System flexibility to address seasonal variations in supply and demand is accommodated through a recently permitted recharge facility at the plant. The City plans to construct a second water reclamation plant in north Phoenix in the future.

Cave Creek Water Reclamation Plant

Phoenix is a member of the Sub-Regional Operating Group (SROG), a cooperative of Valley cities that own and operate the 91st Avenue Wastewater Treatment Plant (WWTP). The WWTP delivers treated wastewater to the Tres Rios wetlands. This wetlands complex removes additional nutrients and metals from the treated water. Reclaimed water from the plant is also currently delivered, via the Salt and Gila rivers, to the Buckeye Irrigation Company (BIC), and is a valuable water supply for Arizona Public Service's Palo Verde Nuclear Generating Station which uses this water for plant cooling purposes.

Phoenix also delivers reclaimed water from the 23rd Avenue WWTP to the Roosevelt Irrigation District (RID) for farming purposes. The arrangement with RID provides the City access to SRP supplies through an exchange agreement, and generate groundwater pumping credits through "in-lieu" recharge. These features are more fully discussed in Chapter 2.

ARIZONA'S 1980 GROUNDWATER MANAGEMENT ACT

The City lies within the Phoenix Active Management Area (AMA), one of several water planning and regulatory areas established by the Legislature through the 1980 Arizona Groundwater Management Act (or "Groundwater Code") (Figure 1-2). This comprehensive legislation and associated regulations establish groundwater rights, conservation requirements, subdivision "assured water supply" standards and a host of other features designed to protect groundwater supplies which have been "overdrafted" in the area. The key goal established by the Groundwater Code for the Phoenix AMA is "safe-yield" by the year 2025. This involves the balancing of groundwater withdrawals with the volume of water which recharges area aquifers. The Groundwater Code establishes specific requirements for water providers, farms, industries and others with the intent of meeting the safe yield target. The acquisition of CAP supplies and the continued use of SRP supplies have allowed Phoenix to substantially reduce its groundwater withdrawals in recent years, keeping Phoenix consistent with this goal. However, groundwater wells remain a critical part of Phoenix's water portfolio and will be needed as a supplemental source of water.

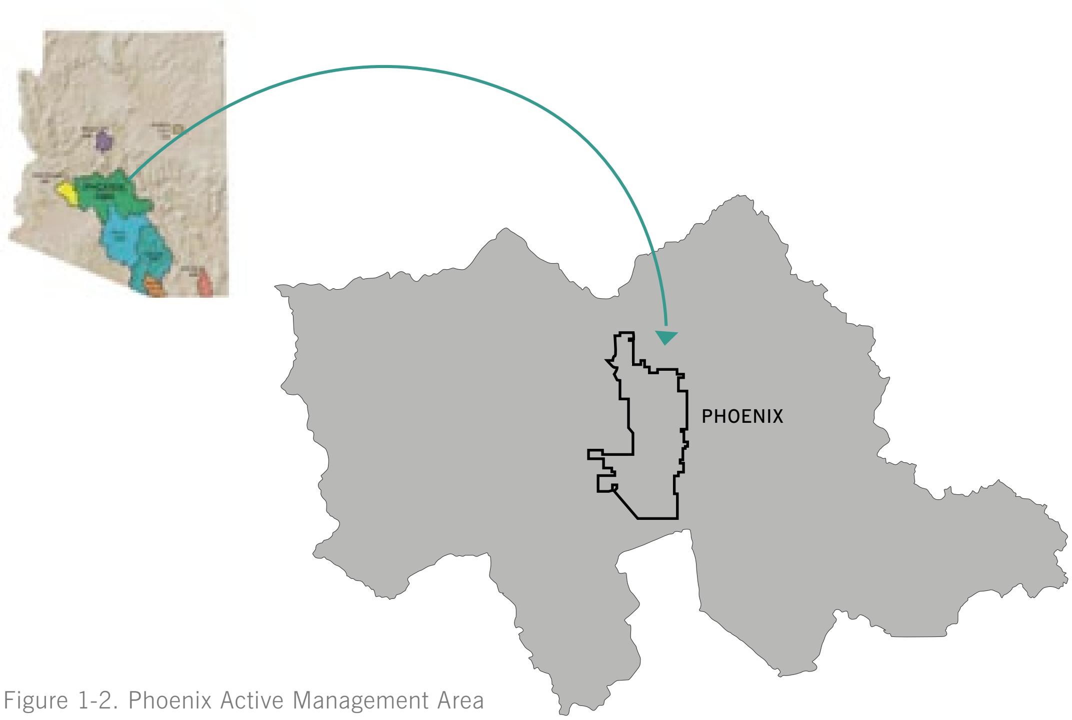


Figure 1-2. Phoenix Active Management Area

Assured Water Supply | Arizona's Assured Water Supply (AWS) Rules became effective in 1995. These Rules require a demonstration of at least 100 years of supply for growth. Phoenix's success in water resource planning has led the State of Arizona to grant a "Designation of Assured Water Supply" to the City. This affirms that the City has at least 100 years of water available to serve existing customers and all anticipated growth occurring through the year 2010 – the furthest date considered by the State at this time. In fact, the current plan demonstrates that the City has a 100 year supply for existing demand and growth at 2020 levels under normal (non-drought) conditions. Chapter 6 describes water supplies and strategies envisioned for future assured water supply demonstrations.

Conservation Requirements | A series of five "management plans" called for under the Groundwater Code specify enforceable conservation targets for municipal, industrial and agricultural water users. Phoenix has been proactive in maintaining compliance with these requirements, contributing to significant per-capita water use reductions in Phoenix. A much stronger "conservation ethic" has developed from both voluntary customer actions and compliance with city ordinances which "hard wire" efficiencies into new construction. Chapter 3 describes conservation practices within Phoenix in more detail.

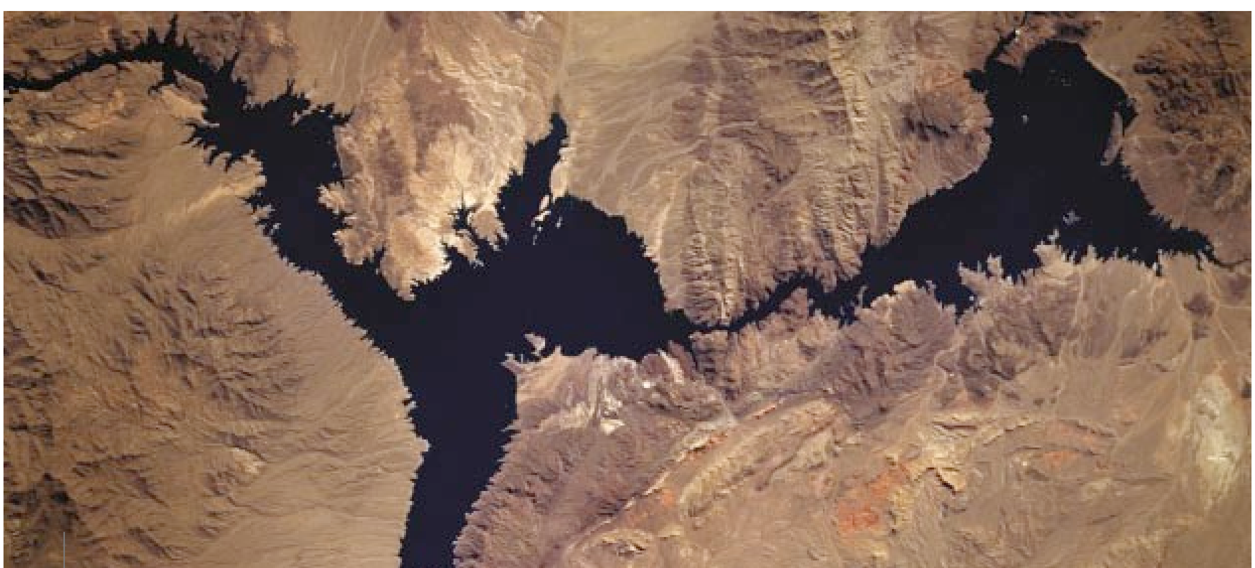
CENTRAL ARIZONA GROUNDWATER REPLENISHMENT DISTRICT

In 1993, the legislature created a groundwater replenishment authority to be governed by the CAP Board of Directors throughout the tri-county CAP service area. This replenishment authority, commonly referred to as the Central Arizona Groundwater Replenishment District (CAGRD), provides a means for landowners and water providers to demonstrate consistency with the State's Assured Water Supply Rules. In effect, the CAGRD allows development to occur on groundwater supplies if lots or entire service areas have been enrolled as members. Members pay the CAGRD to obtain renewable water supplies and replenish the aquifer, although not necessarily in the same area. The supplies accessed by the CAGRD for this purpose need not be permanently available. The CAGRD "Plan of Operation," updated and approved by ADWR in 2005, spells out replenishment options and plans through 2015.

Phoenix does not need to become a member of CAGRD as its renewable supplies are available in sufficient quantities to meet the AWS standard. However, the CAGRD mechanism impacts growth patterns in the region by allowing communities without direct access to renewable water supplies to develop on locally available groundwater supplies (to a maximum depth of 1,000 feet below land surface). Much of the growth occurring in the urban fringe of the Phoenix metropolitan area is made possible by this mechanism. Concerns have been raised regarding the ultimate potential capacity of CAGRD growth and long term supply reliability for its members in the face of increasing regional competition for renewable water supplies.

COLORADO RIVER NEGOTIATIONS

The Secretary of the Interior has initiated a public process to consider alternative methods for operating the Colorado River and for creating shortage criteria to allocate water during times of drought. At the same time, a cooperative effort among the seven Colorado River Basin States to establish guidelines for managing reservoirs under drought conditions is underway. The Secretary of the Interior has stated that rules addressing these issues must be in place by December 2007. In addition, discussions are ongoing within Arizona to determine how the State will manage shortages among its junior priority Colorado River users. The outcome of these negotiations is of critical importance to Phoenix and all CAP subcontractors due to the low priority of the CAP relative to other Colorado River contracts. This is discussed further in Chapters 2 and 4.



Lake Mead



ENVIRONMENTAL COMPLIANCE

Safe Drinking Water Act | The Safe Drinking Water Act (SDWA) was passed by Congress in 1974. The SDWA authorizes the U.S. Environmental Protection Agency (EPA) to set national health-based standards for contaminants. The EPA is currently evaluating the risk from microbial contaminants like cryptosporidium, disinfection byproducts, radon and arsenic. The Arizona Department of Environmental Quality (ADEQ) is responsible for the implementation of some elements of the SDWA. In 2001, the EPA required public water systems to comply with new arsenic standards. In Arizona, arsenic occurs naturally in soil and in water at levels above the new standard. The previous standard of 50 parts per billion (ppb) has been reduced to 10 ppb. The City has taken steps to comply with the new standard, which became effective in January 2006.

As new contaminants are identified and maximum contaminant levels are established, the City must reassess the state of the drinking water supply and make adjustments in monitoring, reporting and treatment in order to comply with the new standards.

National Environmental Policy Act | The National Environmental Policy Act (NEPA) establishes national policy and goals for the protection, maintenance, and enhancement of the environment and provides a process for implementing these goals within federal agencies. Water development, treatment, recharge or transmission projects may be subject to this law to the degree that federal funding and/or the utilization of federal lands are involved. The NEPA process consists of an evaluation of an action or its alternatives on the environment. To comply with NEPA, the federal agency may choose various levels of analyses. The most complex analysis is an Environmental Impact Statement (EIS). An Environmental Assessment (EA) may be done for less complicated projects. In other cases, the federal agency may determine that a finding of no significant impact (FONSI) or a categorical exclusion meets the NEPA standards. The public, other federal agencies and outside parties are afforded an opportunity to provide input into the NEPA process. As an example of a current NEPA analysis involving the City, an EIS is being prepared for the proposed Agua Fria Linear Recharge Project (discussed in Chapter 6). This project involves a partnership between Phoenix, other area cities and the U.S. Bureau of Reclamation (USBR).

Southwestern
Willow Flycatcher

Endangered Species Act | The Endangered Species Act is a regulatory program to protect threatened and endangered plants and animals and the habitats in which they are found. The U.S. Fish and Wildlife Service (USFWS) implements the ESA and maintains a list of 632 endangered species (326 are plants) and 190 threatened species (78 are plants)[2]. The ESA essentially prohibits the "take" (killing, harming or harassing) of endangered species. Both federal agencies and non-federal parties must comply with the ESA, but obligations under the ESA differ for federal agencies and for non-federal parties. However, projects that are federally funded, permitted, or have some other federal nexus must also be evaluated for compliance with the ESA. In arid regions, most plant and animal species are concentrated near streams and rivers. For this reason, large scale water storage and transmission activities associated with the City water supplies are sometimes implicated in ESA compliance activities. In some cases, current or anticipated impacts to species have resulted in agreements between USFWS and area water purveyors to permit specific activities and to support endangered species and their habitats, while allowing water development and delivery to continue.

For the City, the most prominent ESA issue to date involves the southwestern willow flycatcher and potential impacts on the City's Salt and Verde river water supplies. In 1993, the flycatcher was found nesting at Roosevelt Lake. Negotiations between SRP and the USFWS resulted in the development of a Habitat Conservation Plan (HCP) and the granting of an "Incidental Take Permit" for the flycatcher and other species. Implementation of the HCP provides ESA compliance for the flycatcher and other species, while allowing full utilization of the reservoir. Additional populations of the flycatcher have been identified at Horseshoe Lake (on the Verde River). An HCP covering the operation of Horseshoe and Bartlett lakes is being negotiated by the City of Phoenix, SRP and USFWS.

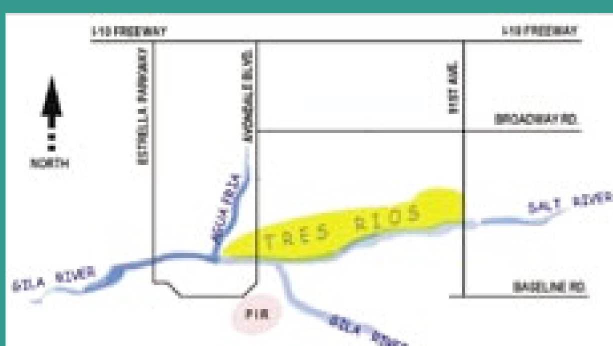
The City's CAP water supply is potentially impacted by endangered species on the Colorado River. In April 2005, the states of Arizona, Nevada and California, and the USBR completed and initiated funding of the Lower Colorado River Multi-Species Conservation Program. This large scale HCP allows for the present and future operation of the lower Colorado River from Lake Mead to Mexico, while maintaining compliance with the ESA.

Additional ESA compliance issues will likely develop over time with the listing of additional threatened or endangered species, and with the designation of "critical habitat" areas for these species. The City will continue to monitor ESA issues and may become involved in future activities that allow for continued operation of City functions while maintaining compliance with the ESA.

[2]*Environmental Protection Agency Website, December 2005*

TRES RIOS DEMONSTRATION PROJECT

In 1995, Phoenix, in partnership with SROG, the USBR, the U.S. Army Corps of Engineers and other key agencies and volunteer organizations, constructed the Tres Rios Demonstration Wetlands Project at a cost of $4.5 million. The concept originated from a need to find a cost-effective way of treating effluent from the 91st Avenue WWTP to meet more stringent water quality standards for continued discharge of water to the Salt and Gila river system. The demonstration project is composed of approximately 12 acres of artificial wetland systems that provide advanced water treatment, enhanced wildlife habitat and passive recreational opportunities. Operation of the wetlands has proven a very successful way of achieving water quality objectives and has been well received by the community. The project has provided habitat for a variety of wildlife species and recreational opportunities, and has garnered support for the full scale project.

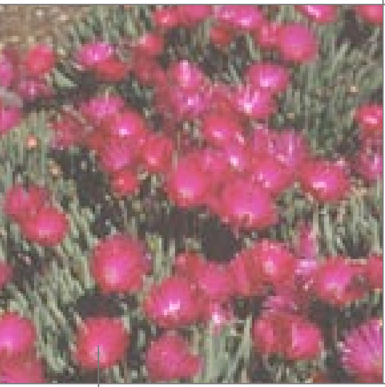


Design and construction work for the full-scale project have begun, led by the Army Corps of Engineers. The flood control levee construction is currently underway, and the project schedule currently estimates completion of the entire project by 2010. The six-mile long, approximately $110 million project will incorporate flood control objectives, water quality treatment, habitat enhancement and recreational features.

CHAPTER II
WATER SUPPLY PORTFOLIO

CHAPTER 2

WATER SUPPLY PORTFOLIO



Red Spike Ice Plant

Phoenix's water needs are met through a diverse portfolio of water supplies assembled over many decades. Supplies are commonly grouped into four major categories:

- Surface and groundwater supplies delivered through the SRP;
- Colorado River water delivered through the CAP;
- Groundwater pumped from City wells
- Reclaimed water (or treated wastewater effluent).

In a normal supply year, more than 90 percent of the City's demand is met with surface water provided by SRP and CAP (Figure 2-1). In some years, a portion of the supply received from SRP may consist of groundwater pumped from SRP wells to cover surface water shortfalls. The City also maintains a number of wells for operational flexibility and for use when CAP and/or SRP supplies are reduced. The dynamics of these supplies under a variety of growth and drought scenarios are explored further in Chapter 4.

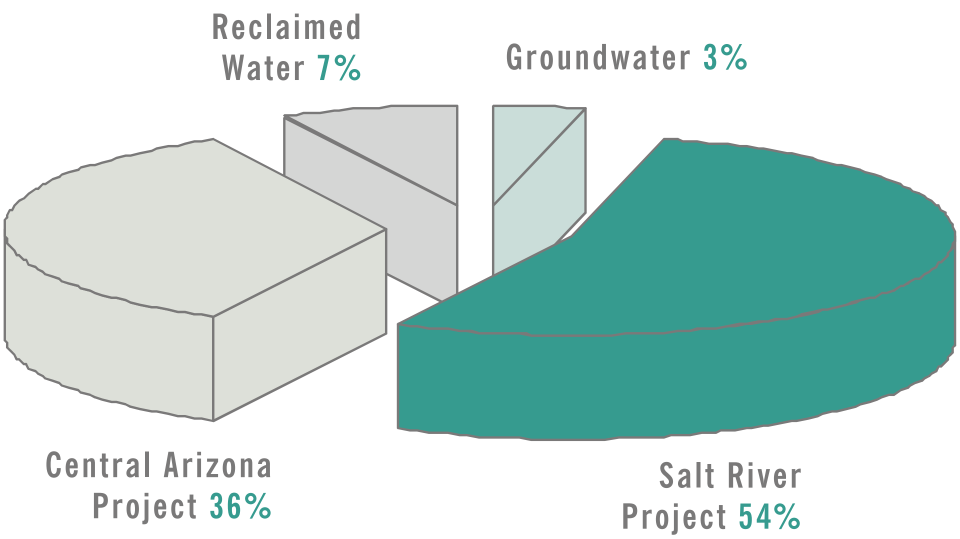


Figure 2-1. Normal Year Supplies

Upper Salt River

NORMAL YEAR SUPPLIES

Water supplies available through both the SRP and CAP systems are based on a wide variety of water rights entitlements, contracts, leases, exchanges and other mechanisms. These supplies are divided into those which can be used only within areas entitled to receive SRP water (i.e., lands within the boundaries of SRP), and all other lands within Phoenix. The distribution of these supplies adheres to the legal and contractual obligations associated with each source, but the City's system provides water to all customers in a seamless manner. Figure 2-2 generally illustrates the current and future supplies available to the City.

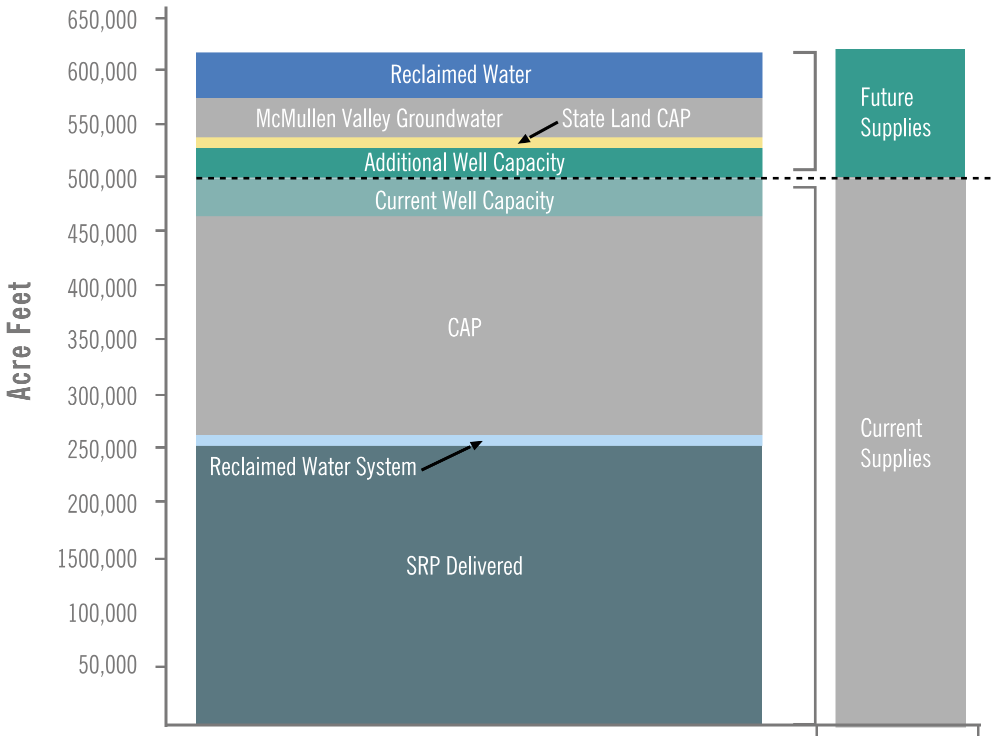


Figure 2-2. City of Phoenix Current and Future Water Supply Portfolio

SUPPLIES AVAILABLE FOR "ON-PROJECT" (SALT RIVER PROJECT) LANDS

The SRP system is composed of six dams, 1,300 miles of canals and laterals and 255 high-capacity wells. The project delivers approximately one million acre feet (AF)[3] of water per year to municipal, residential and agricultural customers within Project boundaries, which includes portions of several Valley cities. Deliveries for lands within the City of Phoenix encompass between 20 and 25 percent of SRP's on-project deliveries. Surface water supplies are derived from Salt and Verde river watersheds north and east of Phoenix (Figure 2-3).

[3] 1 acre foot equals 325,851 gallons (enough to serve 3-4 families for one year)

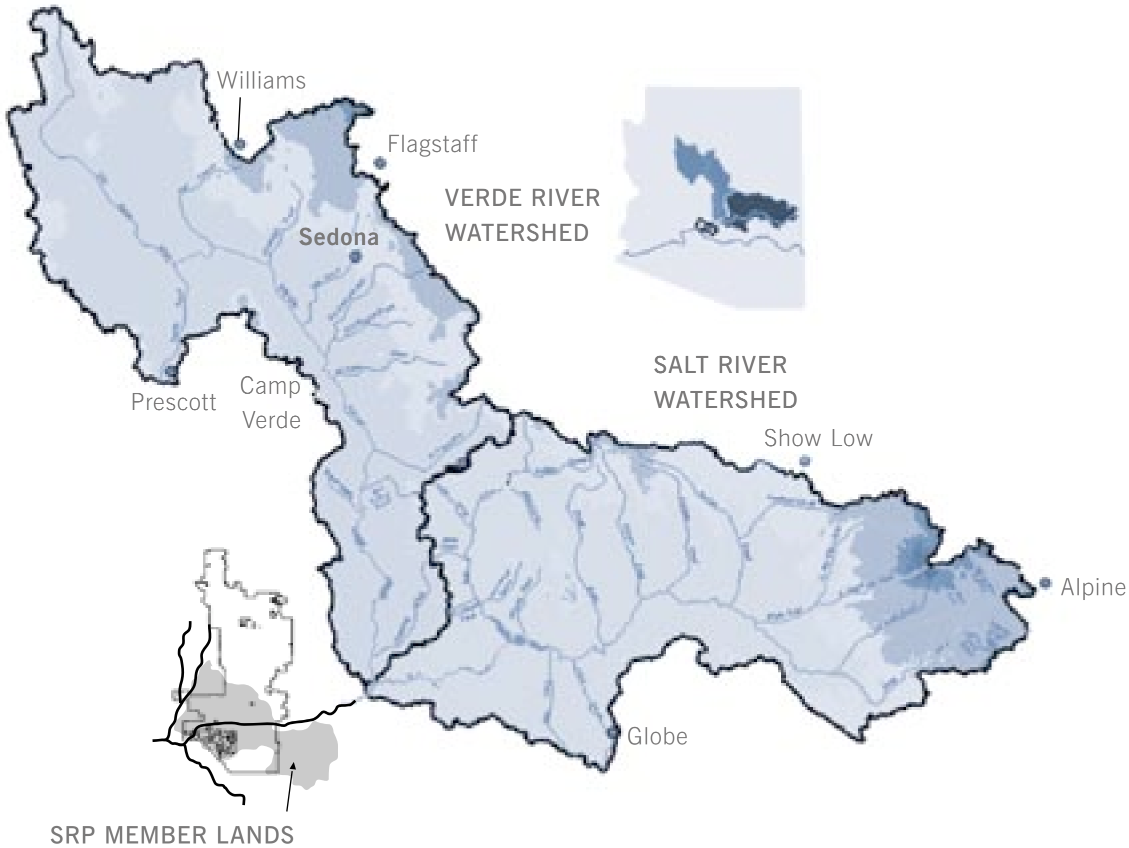


Figure 2-3. Salt and Verde River Watersheds (courtesy Salt River Project)

The lands eligible to receive SRP supplies are commonly referred to as “on-project” lands. More than 100 years ago, these early farmlands lands established rights to the Salt and Verde rivers. The lands were pledged as collateral in exchange for the federal government’s construction of Roosevelt Dam and the delivery system under the 1902 National Reclamation Act. The City now receives this water from SRP at water treatment plants, and distributes it to on-project lands which have urbanized. Some lands continue to receive direct deliveries of non-potable SRP supplies for urban landscape watering purposes.

Roosevelt Lake and Dam

Shortages | SRP has historically managed the reservoir system and its extensive well network to maintain a consistent supply of water to shareholders, despite extreme flow variations in the watershed from year to year (Figure 2-4). Only twice in the last 100 years (in 1951 and again in 2003-2004) was there a need for SRP to reduce annual allocations to on-project lands.

Due to urbanization of the on-project area, many SRP network wells have become “stranded.” In effect, these wells which historically produced water for farms (to supplement surface water supplies) are not accessible to the major canals which serve municipal water treatment plants. SRP is pursuing the restoration of well capacity to historic levels to minimize the impact of future surface water shortages on municipalities and remaining irrigated lands.

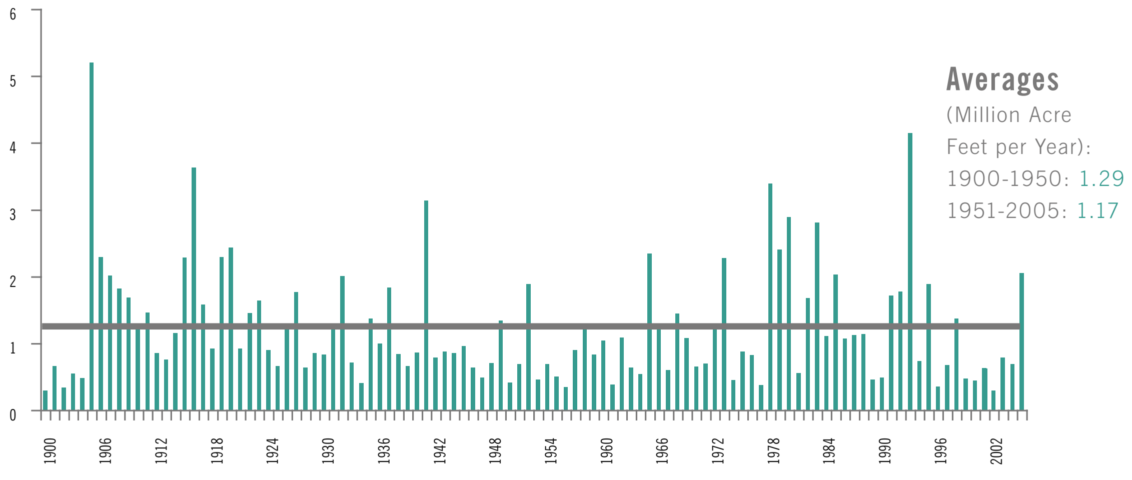


Figure 2-4. Total Annual Inflow - Salt and Verde Rivers (1900-2004)

Allocations | Water supplies available for on-project use include the following:

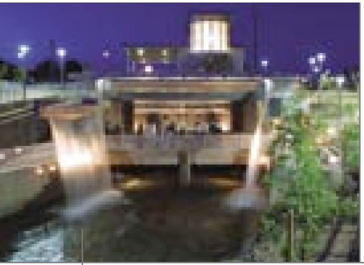
Stored and Developed Water is surface water stored in SRP reservoirs for use on lands with historic water rights. During dry years or for operational purposes, groundwater pumped by SRP supplements the surface water. Water associated with approximately 78,000 acres of eligible land is currently available to the City of Phoenix. The normal-year allocation is typically 3 AF per acre, but the SRP Board may reduce this allocation under low reservoir or low-flow conditions or increase this allocation during surplus-flow conditions.

Normal Flow Rights are entitlements to the flow of the river as it existed before construction of SRP reservoirs. These are the most senior (secure) rights, and are appurtenant to specific on-project lands upon which water was first delivered for use. The quantity to be available varies depending on river flow conditions, but is generally expected to be in the range of 45,000 and 70,000 AF per year

Townsite Lands (those comprising the early boundaries of the Phoenix townsite) were not incorporated within the original Reclamation Act. The Townsite Act of 1906 amended the original act and authorized water supplies from reclamation projects to be made available for non-agricultural purposes. Eligibility of water for these lands have been affirmed in contracts with SRP.

The City also has access to a small quantity of surface water associated with the Peninsula-Horowitz area in southwest Phoenix. While not considered "on-project" supply, the water right (2 AF of surface water per acre) is similar in that it can be delivered by the Phoenix potable system only for specific farmlands which have urbanized. Approximately 2,000 acres are eligible, though only a small percentage have urbanized to date.

Bartlett Lake and Dam



Arizona Falls on
SRP's Arizona Canal

SUPPLIES AVAILABLE TO ALL SERVICE AREA LANDS

With the exception of the SRP supplies described above, all water sources available to the City may be used anywhere within the City limits. These sources include CAP supplies, groundwater, reclaimed water and additional surface water supplies obtained through the SRP system.

Central Arizona Project Supplies | The CAP conveys surface water from the Colorado River at Lake Havasu approximately 190 miles to Phoenix. The CAP continues another 120 miles to its terminus south of Tucson. The canal was completed to Phoenix in 1986, and to Tucson in 1992. The system utilizes a series of pumps and an integral storage reservoir (Lake Pleasant) on the Agua Fria River. The canal was designed to convey CAP's 1.5 million acre-foot entitlement, and is capable of carrying up to 1.8 million AF per year (Figure 2-5).

Figure 2-5. Colorado River Watershed and Basin Allocations

COLORADO RIVER ALLOCATIONS

Upper Basin (7.5 MAF)

Colorado 52%
Utah 23%
Wyoming 14%
New Mexico 11%

Lower Basin (7.5 MAF)

California 4.4 maf
Arizona 2.8 maf
Nevada 0.3 maf

Mexico (1.5 MAF)

Lee's Ferry

Shortages | As a result of negotiations involving the authorization of the CAP, Arizona agreed that the CAP would maintain a junior status on the Colorado River relative to California's 4.4 million acre-foot allocation. This means that when the Federal government deems that there are insufficient supplies available to meet the combined allocations for Arizona, California, Nevada and the Republic of Mexico the 1.5 million AF associated with the CAP would be cut first (along with deliveries to Mexico and Nevada).

Figure 2-6 illustrates variations in Colorado River flows at Lees Ferry (just downstream from Lake Powell). This record of natural flows illustrates a decline in runoff since the time when the allocations to the seven Colorado River Basin States were established based on the higher flow conditions of the early 1900s. An analysis of 500 years of tree ring records also demonstrates that the flows of the early 1900s are likely to be high in comparison to the long-term average. This illustrates the strong likelihood that the Colorado River system is overallocated.

Arizona's vulnerability to shortages has led to creative solutions such as the underground storage or "banking" of excess Colorado River supplies through the Arizona Water Banking Authority (AWBA) and by individual water providers. To date, the AWBA has stored more than two million AF for use during future CAP cutbacks. While this will not fully insulate CAP customers from shortage, it will reduce the impacts.

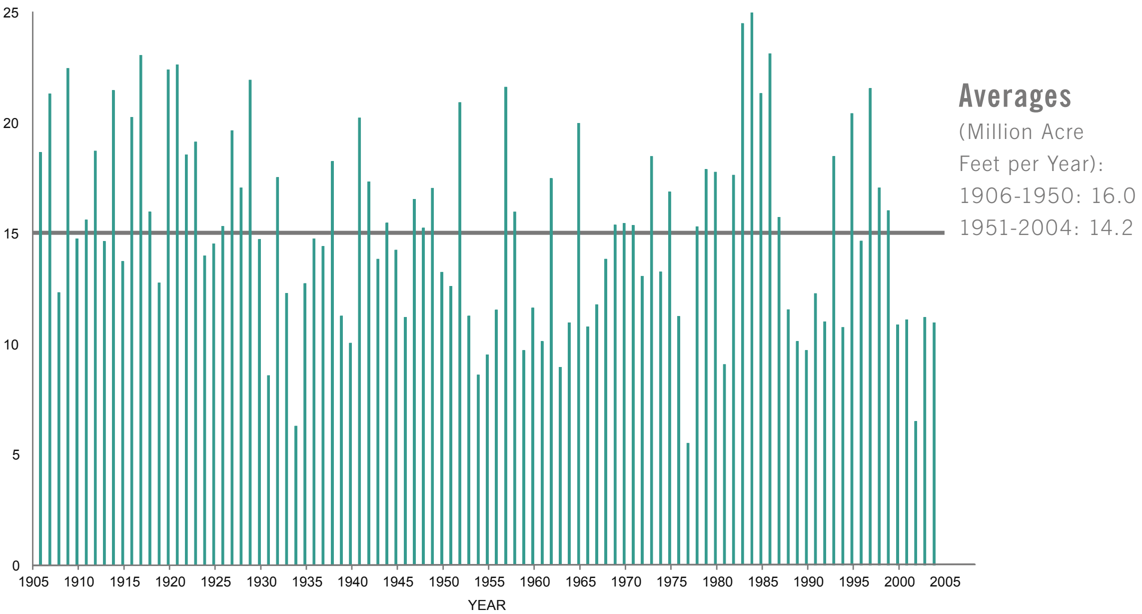


Figure 2-6. Natural Colorado River Inflow at Lee's Ferry, AZ

CAP ALLOCATIONS

The City of Phoenix has access to approximately 185,000 AF of CAP water. CAP supplies are available to Phoenix through both long-term sub-contracts and leases with Indian communities. Most of the water is considered “high priority” within the CAP’s priority system. CAP supplies are summarized as follows:

Municipal and Industrial Subcontract | Phoenix’s Municipal and Industrial (M&I) subcontract with the CAP provides for delivery of up to 122,120 AF of water per year. This includes 8,206 AF associated with the Arizona Water Settlement Act (signed by President Bush in December 2004), which is expected to be available to Phoenix in the next 2 years. M&I subcontracts are among the highest priority allocations (last to be reduced) within the CAP system. All of the “subcontract” water available in Arizona has been allocated.

Colorado River Exchange | As part of the SRPMIC Water Rights Settlement Agreement, Phoenix obtained 4,751 AF per year of mainstem Colorado River water (after deducting losses). Mainstem Colorado River Water is technically not CAP water, though it is delivered through the CAP system. The water maintains the same priority as M&I CAP allocations.

Indian Leases | The City maintains long-term leases with the Fort McDowell Indian Community and the SRPMIC for a combined 7,323 AF per year. This Indian-Priority water is similar in standing to M&I water with regard to shortages. Pursuant to the Arizona Water Rights Settlement Act, which included a settlement of the GRIC water rights claims, Phoenix is now authorized to lease 15,000 AF of CAP per year from GRIC. A lease agreement with the GRIC has not yet been executed.

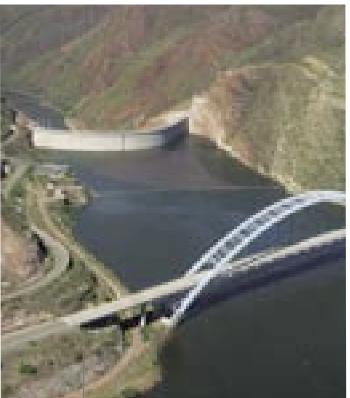
Agricultural-Priority Water | In 1993, Phoenix and other cities entered into an agreement with the Hohokam Irrigation & Drainage District to acquire some of the District’s CAP allocation. Hohokam water carries agricultural priority (lower priority) through 2043, when the supply is upgraded to an M&I priority. Until 2043, this is Phoenix’s most vulnerable supply during Colorado River shortages. The long term contract provides for approximately 36,000 AF per year, though additional water may be available in some years. The City also has access to another 1,000 AF of agricultural-priority CAP which was assigned to Phoenix by the Roosevelt Water Conservation District (RWCD) as part of the SRPMIC Water Rights Settlement Agreement. The allocation can be converted to M&I priority, resulting in 614 AF per year.

Recovery of Stored CAP | Some of Phoenix’s unused CAP water allocation is periodically stored underground at various recharge sites. This water may be recovered (pumped from wells) in future years. To date, the City has stored more than 50,000 AF of CAP water.

CAP

Treatment of CAP Supplies | The bulk of the City's CAP supplies are delivered to the Union Hills Water Treatment Plant located on the CAP Canal. Through an "interconnect facility" that allows CAP water to be diverted into the SRP canals, the City can also provide water to treatment plants on the SRP system. This provides additional system reliability and operational flexibility during droughts or treatment plant maintenance. In addition, the Lake Pleasant Water Treatment Plant, with the first phase set for completion in 2007, will also treat CAP supplies.

Other Surface Water Supplies | The City has access to other surface water supplies from the Salt and Verde rivers which may be used anywhere within Phoenix. These supplies are deliverable through the SRP system, and include the following:



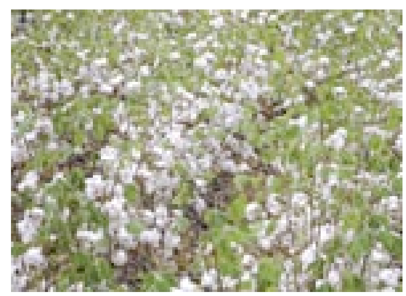
Roosevelt Dam

Gatewater - In 1948, Phoenix entered into a contract with the Federal government and SRP and established a water right for stored water resulting from the construction of gates in the Horseshoe Dam spillway (on the Verde River). Water generated by the spillway gates constructed with Phoenix funds is called "gatewater." The City may accrue up to 150,000 AF of storage credits. This supply is vulnerable to shortages on the Verde. Over the long-term, approximately 19,000 AF per year (after losses) is available to the City.

Roosevelt Dam New Conservation Space - Roosevelt Dam was modified in the 1990's to increase storage capacity on the Salt River to retain flows in the wetter years. Phoenix and other Valley Cities helped fund the construction of the raised dam. This "New Conservation Space" (NCS) water is available when stored water on the Salt River system exceeds pre-Roosevelt Dam modification capacity. The volume varies from year to year. Over the long term, approximately 29,000 AF per year (after losses) is projected to be available to the City.

Reclaimed Water | Between 30 to 40 percent of water delivered to all Phoenix customers (residential and non-residential) ends up at one of the City's three wastewater treatment plants, and is treated for other uses. More than 90 percent of this water is used to meet non-potable water demands in the Valley. This reclaimed water (or effluent) is currently used in the following manner:

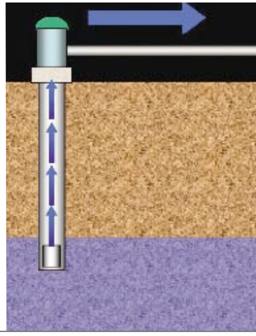
RID/SRP "Three-Way" Exchange - Phoenix delivers up to 30,000 AF per year of reclaimed water from the 23rd Avenue WWTP to the RID, which delivers the water to farms. RID provides a like amount of groundwater to the SRP canal system. SRP then delivers 20,000 AF of canal water per year to Phoenix water treatment plants, and 10,000 AF to SRPMIC. Phoenix may use SRPMIC's unused water in any year. This exchange was developed as a part of the SRPMIC water rights settlement agreement.



North Phoenix Reclaimed Water System - The City produces reclaimed water at the CCWRP for use by turf facilities (five acres and larger). Currently, more than 2,000 AF per year is generated for the delivery to those facilities, and the plant can produce up to 8,000 AF per year at its current capacity. The City has recently begun storing excess reclaimed water underground at the facility for future recovery to meet peak demands.

Recovery of Stored Effluent - Effluent stored underground at the RID Groundwater Savings Facility (GSF) may be pumped by wells which serve the Rio Salado Restoration Project. This water, when pumped, retains the legal classification of effluent. The expected project requirement is approximately 4,000 AF per year, The City has stored approximately 100,000 AF of reclaimed water to date.

Deliveries outside of the Service Area – Under a contract with the BIC, Phoenix may provide BIC up to 40,000 AF per year of reclaimed water from the 91st Avenue WWTP. Phoenix and four other municipalities also contract with Arizona Public Service to provide up to 105,000 AF per year of 91st Avenue reclaimed water to the Palo Verde Nuclear Generating Station for cooling of reactors.



GROUNDWATER

Groundwater may be pumped and used by Phoenix pursuant to Arizona statutes, but with strict controls. The AWS regulations allocate groundwater "allowances" which may be used at any time. These allowances are mostly intended to provide drought relief. Phoenix currently holds more than 2 million AF of groundwater credits for use over a 100 year period. Based on currently available well capacity, and applying a 65 percent duty cycle (i.e., frequency of use), Phoenix can produce about 44,000 AF per year. With an increase in available well capacity, additional groundwater may be pumped, though Phoenix has an obligation to replenish any groundwater used in excess of that provided for in statutes. Selected wells and relative water levels over time are illustrated in Figure 2-7.

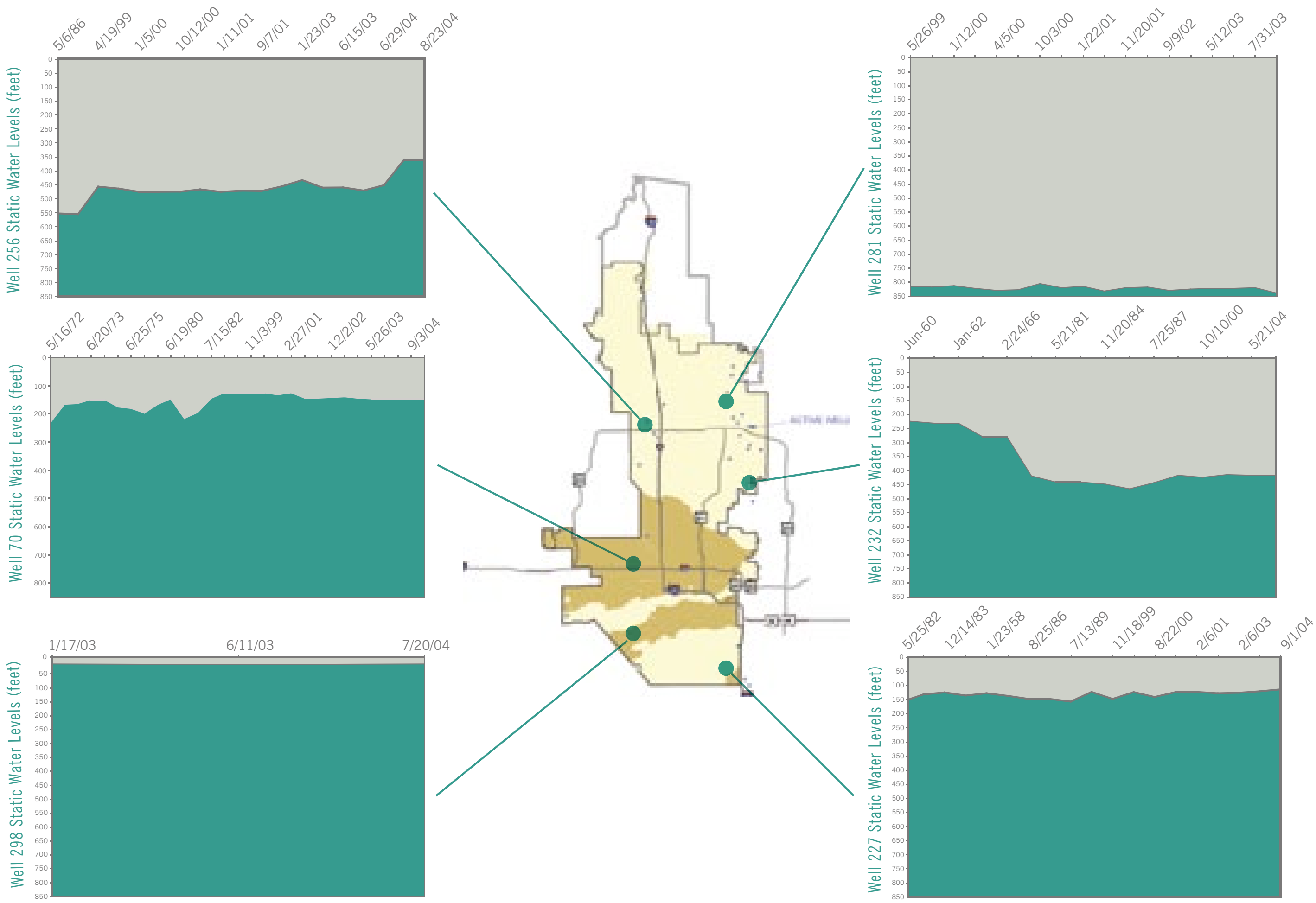


Figure 2-7. Groundwater Levels in Selected Phoenix Wells

FUTURE WATER SUPPLIES

The City has identified several additional water sources to better prepare for growing demands and potentially severe surface water shortfalls. The City will be working towards making these supplies available in the future. These sources and related strategies are more fully discussed in Chapter 6.

Additional Local Groundwater | The City is considering expanding local well production capacity to reduce drought impacts, provide operational flexibility and efficiency, and to meet peaking needs. An expanded well network could also play an important role in recovering stored water credits (i.e., CAP, reclaimed water and other supplies which have been recharged into the aquifer for later use). An expanded well network could also provide needed redundancy in the potable water system.

McMullen Valley Groundwater | In 1986, the City acquired almost 14,000 acres of agricultural lands in the McMullen Valley, approximately 80 miles west of Phoenix. Much of this land continues to be farmed under lease arrangements. The City's intent is to retire these farmlands and transport the groundwater to the municipal water service area. This imported groundwater would be conveyed via pipeline to the CAP canal. The CAP Board has approved an "interim set aside" of 38,000 AF per year of excess CAP canal capacity for transport of McMullen Valley groundwater to Phoenix under the CAP's current wheeling policy.

McMullen Valley Farm

Brackish Groundwater | Desalination of brackish groundwater has been evaluated and considered as one opportunity to meet the increasing water demands of growing West Valley communities. Areas to the southwest of Phoenix are underlain by substantial volumes of relatively shallow brackish groundwater with total dissolved solids (TDS) levels of more than 2,500 milligrams per liter (mg/l). It is generally accepted that water exceeding 1,000 mg/l necessitates treatment before use in potable systems. Studies are currently underway to quantify the sustainable quantity available, and to assess the usability of these brackish supplies by Phoenix and other West Valley communities.

Additional CAP Supplies | A 12,000 acre-foot portion of the M&I-priority CAP supplies allocated to the Arizona State Land Department (ASLD) is being held in reserve for State Trust lands in Phoenix north of Jomax Road. Phoenix's original CAP subcontract allocation was predicated upon Jomax Road as the City's northern boundary. CAP water was allocated to ASLD for lands north of Jomax Road even though ASLD is not a water provider. Based on a 1986 commitment from the ASLD, this allocation will be transferred to Phoenix as State Trust lands as the area north of Jomax Road is developed.

In addition, agricultural-priority CAP water may be available to the City via a state-managed process which will allocate between 75,000 and 90,000 AF to interested parties over three decades beginning in 2010. Presuming Phoenix is successful in obtaining a portion of this supply, a strategy to firm this supply will be needed to offset years where this lower-priority water may be reduced due to Colorado River shortages.

Reclaimed Water | Despite the substantial use of Phoenix's reclaimed water for turf irrigation, cooling and agricultural purposes, additional reclaimed water is available for reuse. The volume produced at Phoenix's plants periodically exceeds demand (especially during winter months), forcing unused water to be discharged to the Salt River. Though a City ordinance requires the use of non-potable water by large turf facilities where practical, the high costs of developing dedicated distribution systems to serve customers in the Phoenix service area remains a major obstacle to direct utilization of the supply. Studies are underway to determine the feasibility of storing some of this unused water underground along the Agua Fria River from Bell Road to Indian School Road. The stored water could ultimately be "recovered" from Phoenix wells to meet both non-potable and potable customer demands. The City is also considering expansion of reclaimed water recharge and recovery facilities in North Phoenix.

As Phoenix water demand grows and existing water resources become more susceptible to drought-related shortages, reclaimed water (a relatively stable water source) will become an increasingly important component in Phoenix's water supply portfolio. A key benefit of reclaimed water is that the available volume increases as overall potable use increases.

24th Street Water Treatment Plant

RIO SALADO HABITAT RESTORATION PROJECT

As of the end of 2005, the City had accrued approximately 100,000 AF of effluent pumping credits through the Roosevelt Irrigation District Groundwater Savings Facility (RID GSF) - discussed later in this Chapter. A major use for these credits is the Rio Salado Habitat Restoration Project along the Salt River channel. This project, substantially completed in 2005, involves the "recovery" of effluent credits (stored at the RID GSF) to supply water for establishing vegetation and water features along the Salt River from 19th Avenue to 24th Street. A similar project referred to as "Rio Oeste" is planned for a reach of the Salt River extending from the 23rd Avenue WWTP to approximately 83rd Avenue. The Rio Oeste project will predominantly use direct flows from the plant, though recovered effluent could be used as a backup supply.

Rio Salado

RECHARGE

The City maintains permits to recharge the groundwater aquifer with CAP and reclaimed water supplies that are not needed to meet current demands. The storage of this water may be pumped or "recovered" in the future when additional supplies are needed for operational flexibility to meet growth and/or drought related demands. The most significant storage permits currently maintained by the City include:

Storage of CAP supplies at the Granite Reef Underground Storage Project (GRUSP) – an open basin facility maintained by SRP and used by several Valley cities. Approximately 800,000 AF have been stored at GRUSP since its inception in 1994

Storage of CAP supplies through SRP's GSF. Phoenix provides CAP water to SRP to replace groundwater that SRP would have otherwise pumped (this is also referred to as "in-lieu" recharge). Phoenix receives credits for the water remaining in the aquifer (less a minimal "cut to the aquifer").

Storage of reclaimed water from the 23rd Avenue WWTP at the RID GSF. This "in-lieu" recharge project allows Phoenix to accrue credits for groundwater which would have otherwise been pumped if not for the water provided to RID. As previously discussed, some of these credits are being used to supply the Rio Salado River Restoration Project, which includes five recovery wells.

Storage of reclaimed water from the CCWRP through vadose zone injection wells. Credits accrued at this facility will be available to meet demands during peak periods (typically summer and fall). The water will supplement the North Phoenix Reclaimed Water Distribution System. The total amount of water stored at each facility (through the end of 2005) is indicated in Table 2-1.

TABLE 2-1 WATER STORAGE FACILITIES AND ACCRUED CREDITS

SOURCE	FACILITY USED	CREDITS ACCRUED THROUGH DEC 31, 2005
CAP	GRUSP	4,058
CAP	SRP GSF	46,930
Reclaimed Water	RID GSF	102,497
Reclaimed Water	Cave Creek[4]	0
TOTAL		153,485

IMPACT OF WATER QUALITY ON SUPPLIES

Drinking water quality standards have increased in significance as an environmental issue over the last two decades. The criteria defining acceptable water quality are undergoing rapid and often controversial change. Historical indicators of water quality included characteristics such as hardness, coliform bacteria, TDS, and inorganic compounds, such as nitrate, arsenic, chromium, fluoride, and iron. Over time, emphasis has shifted to organic compounds such as pesticides, chlorination by-products and industrial solvents.

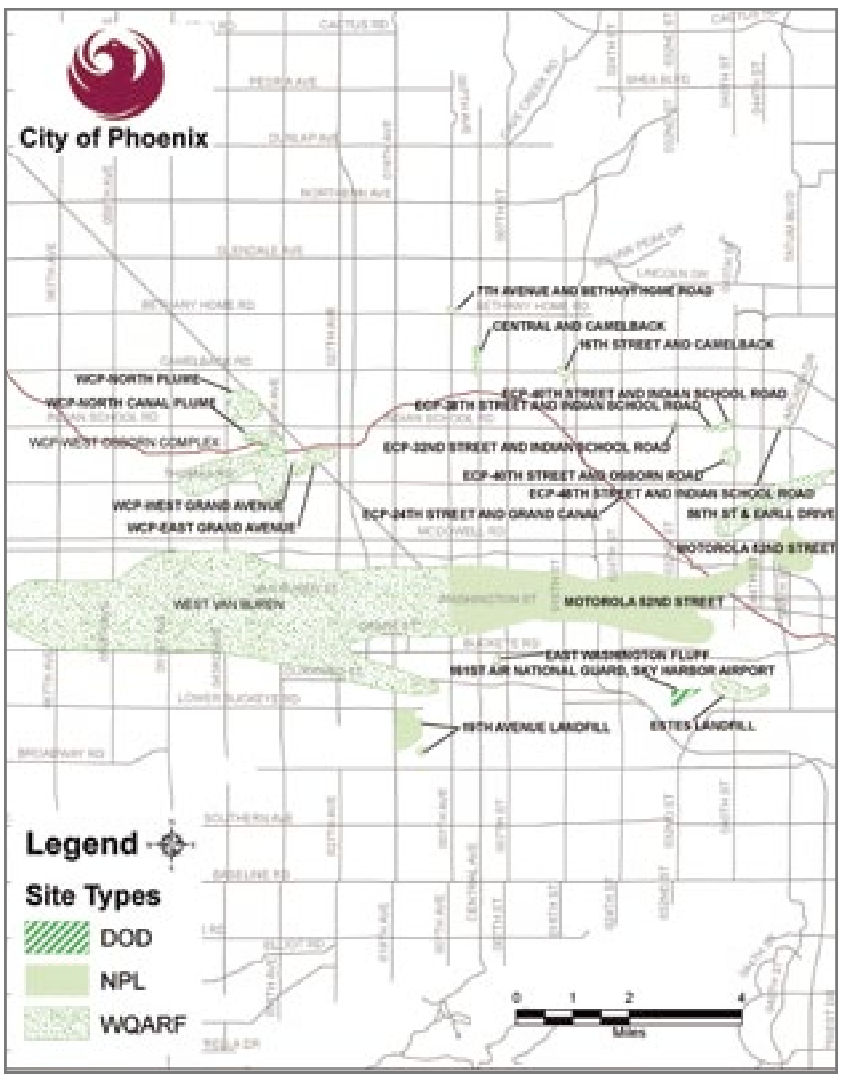
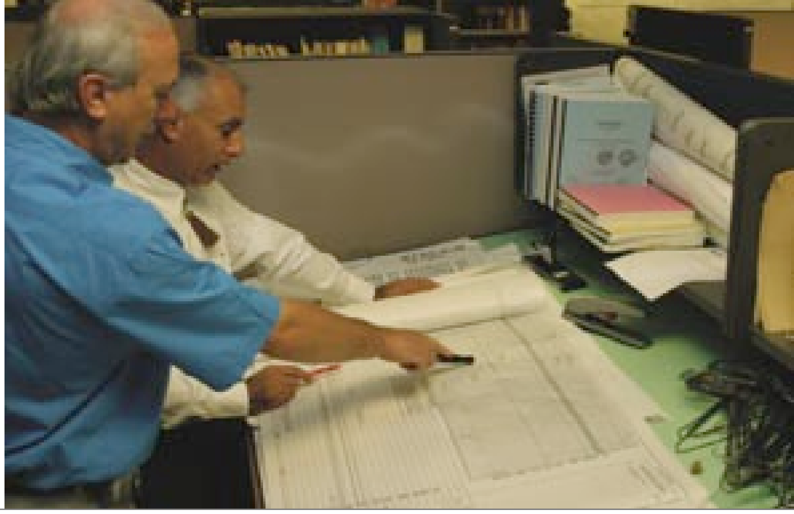


Figure 2-8. Federal and State Superfund Program Sites in the Central Phoenix Area

[4] *Permit was issued in late 2005*



IMPACTS OF CONTAMINANTS ON GROUNDWATER PRODUCTION CAPACITY

Organic Solvents | Organic solvents were first detected in Phoenix drinking water in 1981 when a systematic program was undertaken to sample all water sources for the industrial solvent trichloroethylene (TCE). Since the initiation of the TCE detection program, levels of TCE exceeding drinking water standards have been found in six wells (approximately 8 mgd), resulting in their closure. Trace levels (below the maximum contaminant level) of TCE were found in fourteen other wells (approximately 15 mgd), which have been disconnected. The area generally affected by organic solvent contamination is illustrated in Figure 2-8

The detection of widespread TCE contamination in the early 1980s led to investigation and remediation activities undertaken by the ADEQ, EPA, and parties responsible for the contamination. The City of Phoenix has been actively involved in the effort and is monitoring federal and state superfund activities. To date, the largest contaminant plume in Phoenix is the Motorola 52nd Street Superfund site, which is a federal Superfund site listed on EPA's National Priority List (NPL). The plume contains TCE, Tetrachloroethene (PCE), Trichloroethane (TCA), and the chemicals that are produced when those contaminants break down. The plume extends across central Phoenix, encompassing an area of groundwater which begins at 52nd Street and terminates several miles west of 7th Avenue, generally between McDowell Road and Buckeye Road. This Superfund site is the result of historical spills and other releases of commercial and industrial solvents from facilities throughout the area, which reached the groundwater and caused contamination.

EPA and ADEQ selected interim cleanup plans for the soils and groundwater at the former Motorola 52nd Street facility in 1989, know as Operable Unit 1 (OU1). Motorola (now Freescale Semiconductor) has been operating a groundwater treatment plant at the 52nd Street facility since 1992. Freescale and Honeywell (formerly Allied Signal at 34th Street and Airlane) have been operating a groundwater treatment plant known as Operable Unit 2 (OU2) at 20th Street and Washington since 2002. The purpose of OU1 and OU2 is to contain or halt the spread of the more highly contaminated groundwater.

In 1997, EPA and ADEQ established a third study area known as Operable Unit 3 (OU3) for contaminated groundwater extending past 20th Street. EPA has been researching additional facilities that could be responsible for contamination and is continuing the groundwater investigation in the OU3 area. The contamination extends west of 7th Avenue. However, that contamination is being addressed by the ADEQ Water Quality Assurance Revolving Fund (WQARF) program as part of the West Van Buren site.

There are other WQARF (state Superfund) and federal Superfund sites in the Phoenix area, but the Motorola 52nd street site is the largest. There are at least nine WQARF sites in Phoenix where groundwater has been impacted by PCE from dry cleaners. In the West Central Phoenix area, there is a cluster of 5 individual WQARF sites that are affected by solvent contamination from various industries. ADEQ is actively working on these WQARF sites and has been consulting with the City about future water use when developing remedial (cleanup) objectives. In correspondence and discussions with ADEQ and EPA, the City has emphasized that the central Phoenix aquifer is an important future water supply that the City will need to be able to access.

New Arsenic Treatment
Facility at Phoenix Well #280

Hydrocarbons | Hydrocarbon contamination (from leaking service station fuel tanks) has also impacted well availability. Individual sites are small and dispersed (typically coinciding with abandoned stations). Because this contamination exists in the best producing portions of the aquifer, cleanup of these sites is also essential.

Pesticides | Pesticide contamination has also resulted in a loss of groundwater production capacity. In 1984, the City initiated a program to sample all water sources for specific pesticides. A total of eight wells have been taken out of service due to high concentrations of pesticides, with a total loss of production of 9,000 AF per year (8 mgd).

Heavy Metals | Heavy metal contamination has also resulted in a loss of groundwater production capacity. High concentrations of chromium, a naturally occurring metal, have resulted in closure of seven wells with a combined capacity of 6,700 AF per year (6 mgd).

Nitrate | Nitrate, an inorganic compound found in elevated concentrations due to leaching of fertilizers used for agriculture, has a significant impact on the City's groundwater production capacity. Since 1987, 39 wells with an aggregate capacity of 68,000 AF per year (61 mgd) have been lost due to nitrate levels approaching or exceeding standards (some of these wells also have high levels of organic substances).

Due to the large number of wells affected by high nitrate levels, the Water Services Department has reduced nitrate concentrations by modifying certain wells to withdraw water from aquifer zones of higher quality, and by blending water sources under plans approved by ADEQ.

The total loss of Phoenix well production from 1981 to 2000 due to elevated concentrations of organic and inorganic substances exceeds 90,000 AF per year. This loss stemmed from the closure of more than 60 wells, and represented 60 percent of the total production capacity of all Phoenix wells. Wells which are returned to service in the future will require cleanup of the contaminated aquifers or expensive wellhead treatment systems.

Arsenic | EPA's revised standard for arsenic, a naturally occurring mineral, is mandatory as of January 2006. This new standard of 10 parts per billion (ppb) is considerably lower than the prior maximum contaminant level of 50 ppb, and necessitates the installation of wellhead treatment facilities for several City wells. The initial phase of well modifications addresses 12 wells, with others to follow.

Surface Water Considerations | The SDWA, passed in 1987, applies the same organic monitoring requirements to surface water as to groundwater, and imposes more stringent requirements for filtration and disinfection of all surface water sources. Also, as a part of recent drinking water standard revisions, the concentration limit for disinfection by-products has been lowered considerably. Phoenix has taken appropriate steps to manage treatment plants and distribution systems to meet these revised standards.

Reclaimed Water Considerations | In recent years, methods of detecting pharmaceutically active compounds in drinking water supplies and reclaimed water have become increasingly sophisticated, and have allowed for detection at extremely low concentration levels (parts per trillion). These compounds are found in reclaimed water supplies, and in river supplies that receive discharges from upstream wastewater treatment plants. To date, EPA has not established maximum contaminant levels for these compounds. The City will continue to monitor developments in this area. In addition, aquifer quality standards are becoming increasingly more stringent. Treatment of wastewater to even higher levels may become necessary.

SALINITY MANAGEMENT

Salinity in area source waters is increasingly becoming a key consideration in municipal water supply and infrastructure planning. Higher concentrations of salinity - also referred to as salts or TDS, are progressively accumulating in the soils and water supplies due to the collective impact of irrigation, urban growth, low rainfall and the high mineral content of geologic features. Traditional water treatment practices do not remove salinity.

SRP and CAP surface water supplies are naturally high in salinity due to origin source geology. Phoenix surface water sources range from 300 milligrams per liter (mg/L) to about 900 mg/L (Figure 2-9). TDS in area groundwater ranges from 200 milligrams per liter (mg/L) to more than 2,500 mg/L in the southwest valley (Figure 2-10). Though the EPA has not established a maximum contaminant level (MCL) for salinity, a secondary (non-enforceable) TDS standard of 500 mg/L has been established. This level represents an aesthetic standard, and does not imply any adverse health impacts if the figure is exceeded. Generally, water utilities avoid distributing water in excess of 1,000 mg/L TDS as customer complaints (primarily regarding taste) tend to increase at that level.

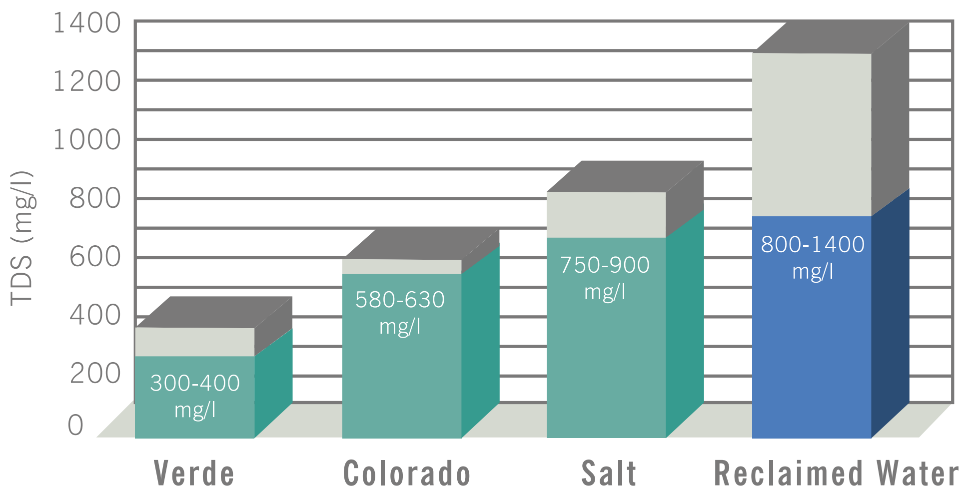
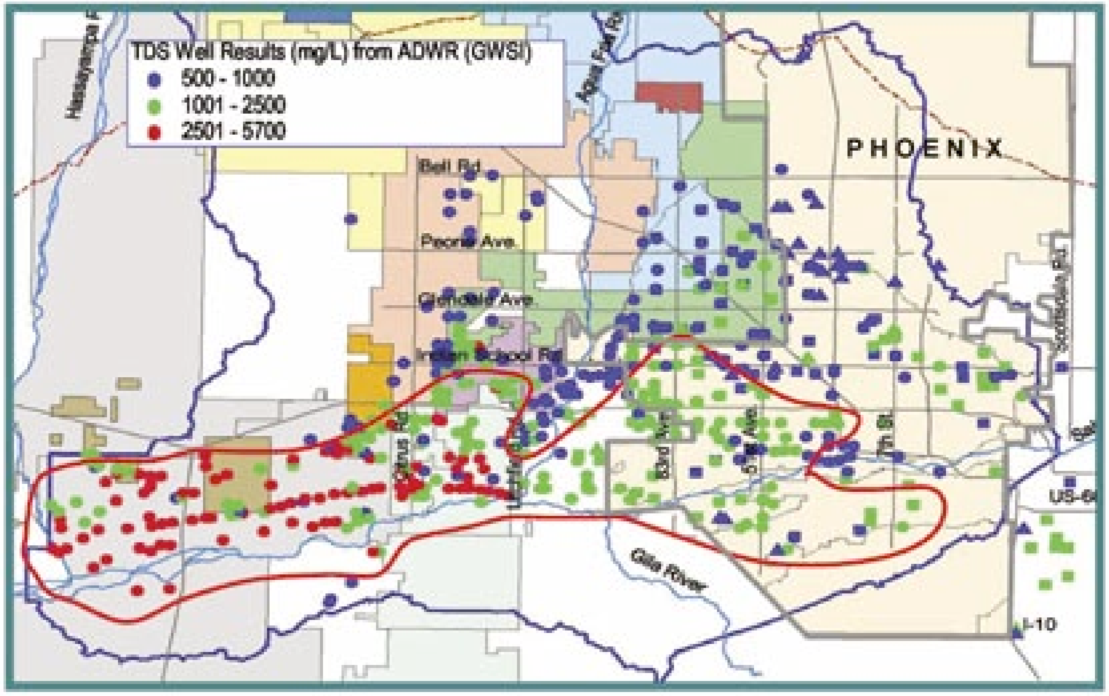


Figure 2-9. Phoenix Area TDS Levels in Various Source Waters



Elevated concentrations of TDS in reclaimed water impede the utilization of this supply for irrigation and for groundwater recharge. Increased TDS levels in wastewater are a result of water softener regeneration discharges, industrial cooling, on-site treatment processes and a number of other point sources. In recent years, the SROG cities noted an upward trend in the salinity of effluent generated at the 91st Avenue WWTP—a supply which is currently used for agricultural and industrial purposes. Salinity levels in reclaimed water at the CCWRP (in Northeast Phoenix) have also been steadily increasing, largely due to water softener and cooling discharges.

In 2001, the Central Arizona Salinity Study (CASS) was initiated as a comprehensive evaluation of salt impacts in the region, and to identify potential mitigation opportunities. The four year two-phase study is a cooperative effort initiated by the SROG cities and the USBR, and involves numerous other stakeholders. Phase 1 of the report estimated that more than 1.5 million tons of salt enter the Phoenix metropolitan area annually, and that 1.1 million tons are retained in soils, water supplies and other "salt sinks." The report also concluded that high TDS levels in water supplies result in at least $60 million per year in damages. These costs are in the form of prematurely aging infrastructure and appliances, soil additives, water softening and other related mitigation actions.

Phase 2 of CASS is evaluating the economics and feasibility of controlling salts at various points in the system, from the source watershed to the WWTPs. It is also evaluating methods for managing the concentrated brine by-product from membrane water treatment processes designed to remove salt. In conjunction with the West Valley Coalition of CAP Subcontractors (WESTCAPS), CASS is also considering the feasibility of converting the highly brackish groundwater reserves of the southwest portion of the Salt River Valley into a usable supply. The Phase 2 effort is expected to be complete in early 2006.

Preliminary CASS findings indicate that prevention of the entry of salts into surface water and wastewater systems may be the most cost-effective means to addressing salinity problems. From a watershed perspective, the Colorado River Basin Salinity Control Forum (CRBSCF), a consortium of the seven Colorado River Basin state representatives, has had substantial success in stemming the flow of salt-laden water into the Colorado River (primarily in the Upper Basin). In partnership with the USBR and the U.S. Department of Agriculture, the CRBSCF has developed irrigation and conveyance system improvement programs which have prevented the entry of roughly 800,000 tons of salt per year into the Colorado River. This reduction allows the United States to meet standards established in its treaty with Mexico, but also benefits downstream urban users. Further efforts will be needed both in the Colorado River watershed, and to the degree practical, within the Salt River Watershed.

Salinity accumulation in soils in the Upper Colorado River Basin (near Price, Utah)

Impacts on salinity on plumbing fixtures

With regard to brackish groundwater, desalination technologies are being used to effectively treat this supply in other parts of the Valley, but the major challenge involves disposal of the brine concentrate byproduct. Studies in the Las Vegas area have estimated that concentrate management costs comprise about 70 percent of total costs of a desalination initiative. In the Phoenix region, the concentrate is typically discharged to wastewater systems. This is not an effective long-term solution as it increases salinity levels in reclaimed water (and thus affects end users of this supply). Several research efforts are underway at the local and national levels to identify and develop cost-effective methods of managing concentrate. Phoenix will continue to monitor and support these and other related efforts.

CHAPTER III
WATER DEMAND PROFILE

WATER DEMAND PROFILE

Red Flower
Pin Cushion

An understanding of the City's water use characteristics and trends is vitally important in determining the appropriate mix and volume of water supplies to be maintained. The City's water use profile, to a large extent, reflects the local economic makeup and the quality of life desired by Phoenix residents and visitors.

In this region, where rainfall is sparse and outdoor activities are highly valued, it is not surprising that almost two-thirds of all water consumed by Phoenix residences and businesses is for outdoor purposes – primarily landscaping and pool evaporation. However, as consumers, homebuilders and others become increasingly "water wise", primarily with regard to outdoor landscaping, a trend in declining water usage rates has become evident.

POPULATION

Population is a major consideration in determining the total volume consumed and in assessing conservation trends. Growth in service area population over the past 15 years is 43 percent, or about 2.3 percent per year (Figure 3-1). The water system currently serves a population of more than 1.4 million residents. This includes the entire Phoenix incorporated area and a portion of the Town of Paradise Valley.

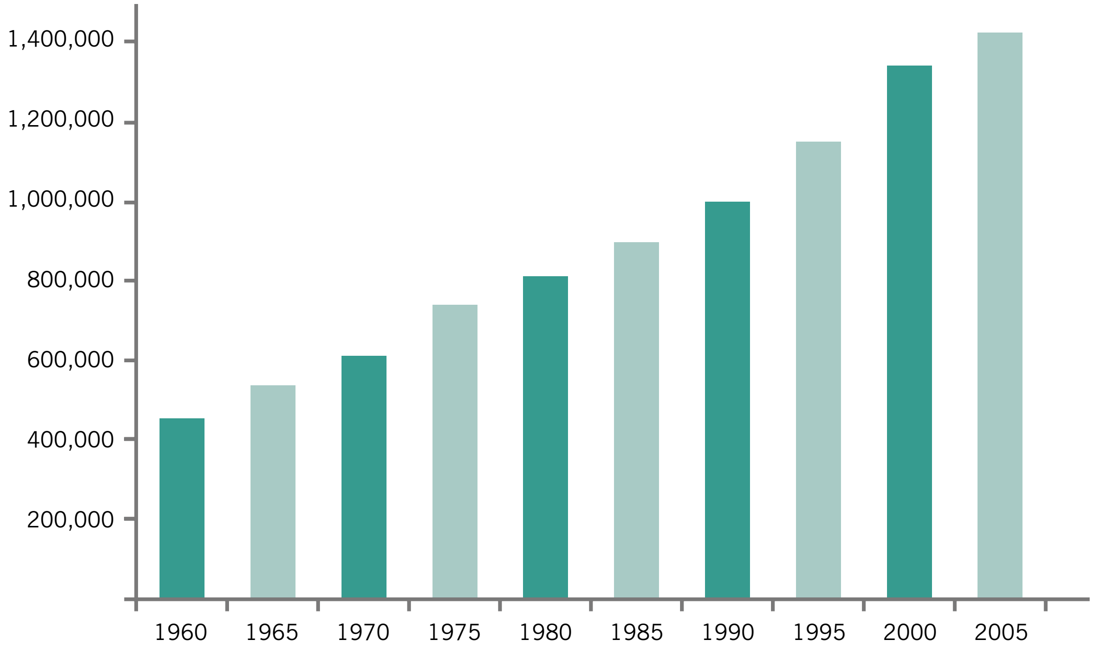


Figure 3-1. Historic Population Growth, City of Phoenix, 1960–2005

A similar rate of growth is likely to occur within the next 15 years. The most recent population projections for the Phoenix service area were prepared by the Maricopa Association of Governments (MAG), and were based on the current Phoenix General Plan. These projections estimate the 2020 population will be 2.03 million. However, Phoenix's actual population growth has typically exceeded projected levels. For example, the last set of MAG projections, compiled in 1997, did not anticipate Phoenix reaching the 2 million threshold until after 2030. A wide variety of factors, mainly related to the economy, will influence Phoenix's actual growth.

PER-CAPITA WATER CONSUMPTION

Water usage is commonly described in terms of an average "gallons per-capita per day" (or GPCD) value, though other measures may be appropriate for specific categories of use. Though the GPCD standard is the simplest in terms of conveying trends, it can be affected by varying the proportion of non-residential uses over time (which may reflect industry and economic trends). The City's overall per-capita rate over the past 25 years is illustrated in Figure 3-2. This represents all water obtained by the Phoenix Water Services Department for service to customers.

While the City's population grew by 43 percent over the past 15 years, total water use grew by only 22 percent (Figure 3-3). This is reflected in a per-capita consumption rate that has dropped approximately 16 percent over that time, and close to 20 percent since the passage of the State's Groundwater Code in 1980. The City's average overall per-capita use for the past four years is approximately 218 GPCD. The 2003 and 2004 rates were lower, in part due to customer awareness and response to regional drought conditions, and perhaps due to above average rainfall in certain parts of the year.

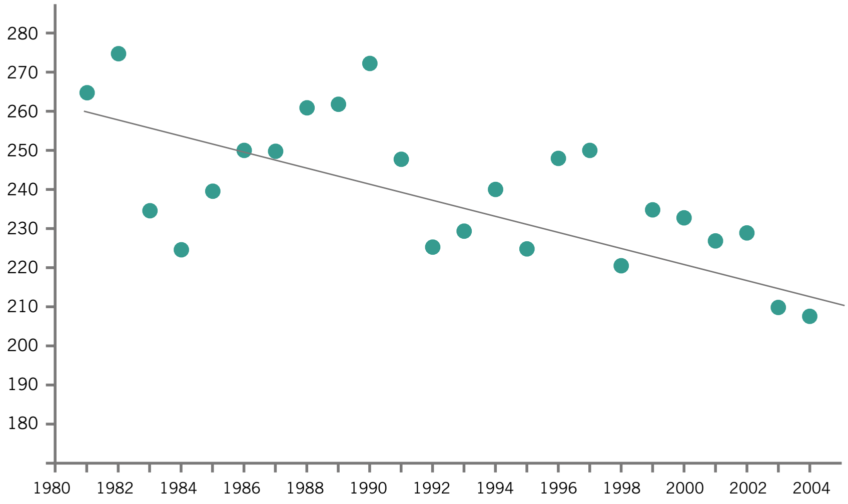


Figure 3-2. Total Per Capita Usage by Phoenix Customers 1980-2004

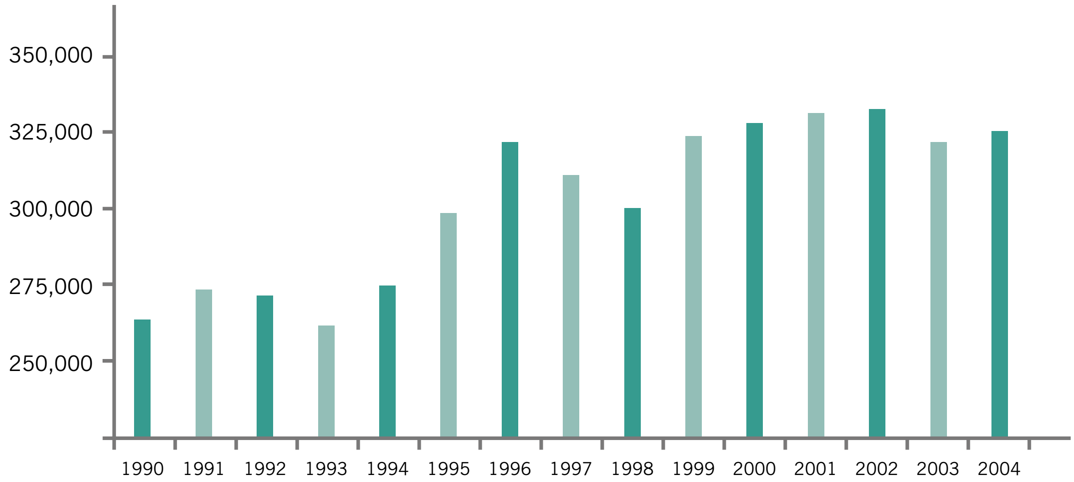
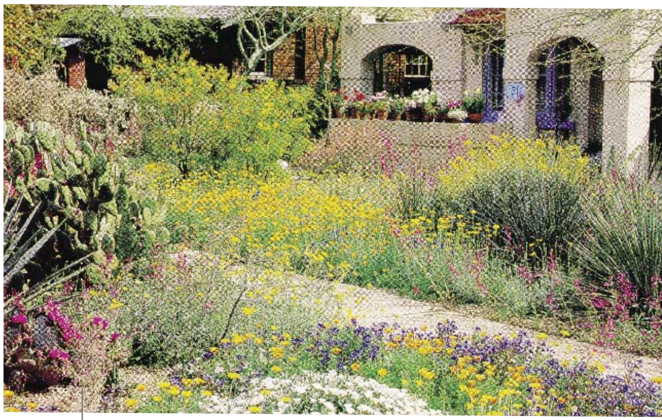


Figure 3-3. Metered Water Consumption by Phoenix Residents, 1990 - 2004

The Arizona Department of Water Resources (ADWR) establishes a target "conservation GPCD rate" for each large water provider. This rate is established in the Groundwater Management Plan for the Phoenix Active Management Area (AMA), and changes with each update to the Management Plan. Phoenix has maintained compliance with the ADWR conservation target rates from the inception of the program. In assessing compliance, the state does not include a municipality's use of reclaimed water (direct or recovered) or water "spilled" from reservoirs during high flow events.

The general reduction in per-capita water use over the past two decades is due in part to the more efficient nature of new construction. The majority of homes constructed over the past two decades tend to have less water-intensive landscaping (and less landscape in general due to smaller lot sizes). In addition, conservation requirements mandated by ADWR and supporting statutes requiring the sale of only high-efficiency plumbing fixtures have also led to the declining rate in per-capita use. The City's conservation program (discussed below), which provides education and common sense approaches for reductions in water use, is also responsible for per-capita use reductions. While it is expected that residential per-capita water use rates will continue to decline, the rate of decline will slow as more efficient construction represents a larger percentage of the total units. The overall rate (for residential and non-residential per-capita use combined) could rise if there is a substantial increase in non-residential growth proportional to residential.

Traditional landscape



Residential xeriscape

WATER DEMAND BY SECTOR

Residential Uses | Approximately two-thirds of the water consumed by Phoenix customers is for residential purposes (Figure 3-4). About three quarters of residential water use is attributed to single family dwellings, and the remainder to multi-family dwellings and mobile homes. Only about one quarter of the residential water use is consumed indoors.

For the residential sector as a whole within the City of Phoenix, the average water use over the past five years is approximately 135 gallons per person per day. Based on information collected for calendar year 2001, the average residential per-capita rate among 13 selected southwestern municipalities was 161 GPCD. One must consider variations in precipitation, temperature and elevation when comparing per-capita use rates, but the City of Phoenix does compare favorably with those 13 southwestern cities.

Non-Residential Uses | Within the non-residential sector, more than one-half of the water consumed is for landscaping and other outdoor uses. Most of the balance is consumed for cooling, industrial processes and sanitary purposes.

Water use by a combination of public and private golf courses, though highly visible, represents less than 3 percent of the total water consumed in Phoenix. Other larger turf facilities (such as parks, schools and common areas) represent another 2 percent. A combination of reclaimed water, non-potable water and potable water are currently used by large turf facilities. However, an increasing proportion of these larger turf-related facilities will use reclaimed water in the future.

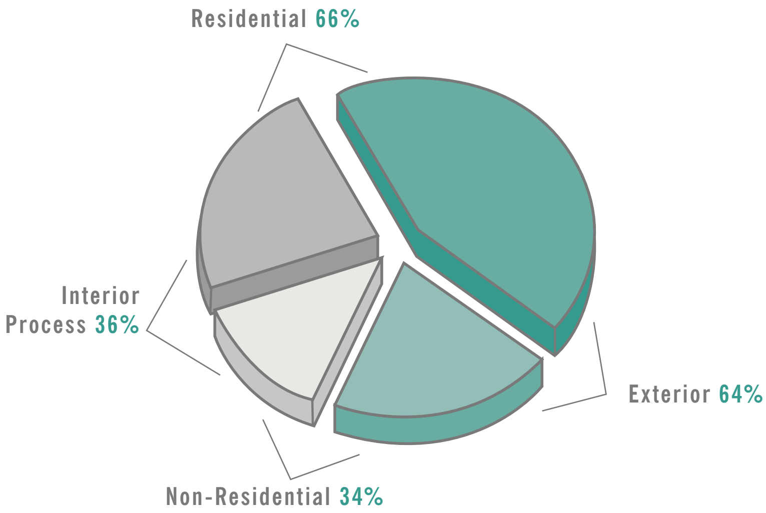
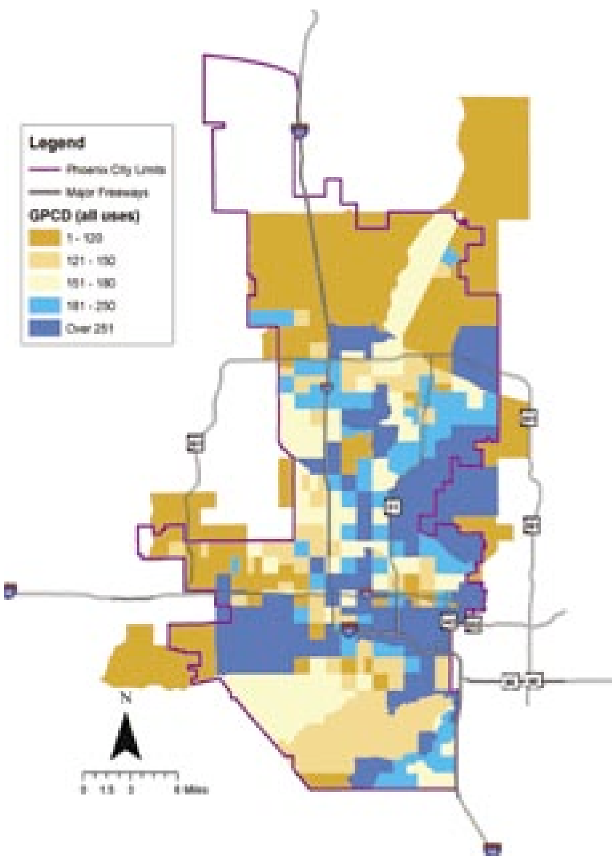


Figure 3-4. City of Phoenix Water Demand by Category

TABLE 3-1 BILLED WATER DELIVERY BREAKDOWN BY CATEGORY (based on 2000–2003 average)

WATER USE CATEGORY ANNUAL USAGE (AF)	ESTIMATED AVERAGE	PERCENT
Residential[5]	**204,800**	**66.4%**
Landscape (estimated)	104,600	33.9%
Pools (estimated)	28,900	9.4%
Indoor (estimated)	71,300	23.1%
Non-Residential	**103,619**	**33.6%**
City golf courses	2,900	0.9%
Non-city golf courses	5,500	1.8%
Public turf facilities (schools, parks, etc)	6,100	2.0%
Other turf facilities (common areas, etc)	319 0.1%	
Landscape (estimated)	48,300	15.7%
Cooling (estimated)	8,300	2.7%
Other (process, sanitary, etc.) (estimated)	32,200	10.4%
TOTAL Deliveries	**308,419**	**100.0%**
SRP Urban Irrigation (not delivered by City)[6]	14,200	



Spatial Variations in Demand | Per-capita water use rates vary substantially throughout the City based on development patterns, socioeconomic conditions, population density, age of development and numerous other factors (Figure 3-5). A better understanding of these varying rates of use will assist in targeting conservation efforts.

Figure 3-5. Spatial Variation in Per-Capita Water Use (Combined Residential and Non-Residential)[7]

[5] *Estimated indoor and outdoor residential use based on "Residential End Uses of Water" report for Phoenix, AZ, Aquacraft, Inc., 1998.*

[6] *Deliveries are made directly to SRP "shareholders" and are not part of the City's Service Area Right.*

[7] *Based on 2000 census and metered water delivery records*

Urban Irrigation | SRP typically delivers between 40,000 and 50,000 AF per year of non-potable canal water for "urban irrigation" purposes in Phoenix (Figure 3-6). These deliveries to homes and businesses in the on-project areas offset the need to irrigate with potable water. Approximately 14,000 acres are eligible for such deliveries within the City. It is anticipated that over time, this figure will gradually decrease as redevelopment projects choose more water efficient landscape design.

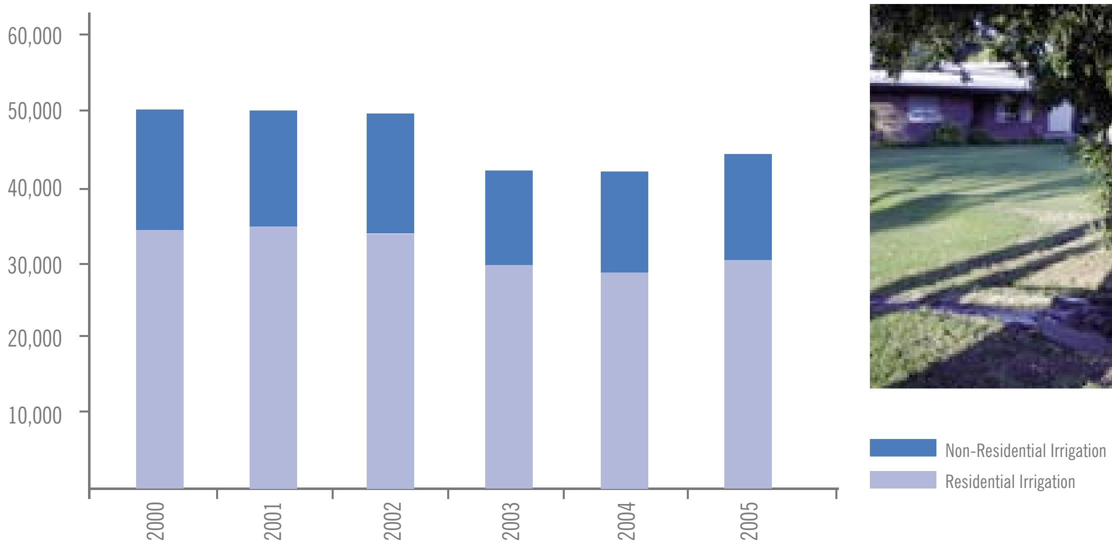


Figure 3-6. Urban Irrigation Deliveries in Phoenix—2000–2005

Seasonal System Demands | The City's average daily demand ranges from 140 mgd in winter months to more than 430 mgd in the peak summer months. Reductions in per-capita water usage, especially for outdoor watering, help control this peak usage and prevent costly expenditures for additional water system capacity.

Weather and Economic Conditions | Variations in local weather and economic conditions may influence water usage in any given projection year. Generally, high temperatures, low rainfall and a good economy increase water use. Above-average rainfall, cooler temperatures and a slow economy tend to reduce water usage. The Phoenix Finance Department's analysis of past conditions and trends point to a variation of 10 percent (plus or minus) as a result of these factors.

CONSERVATION

Over the nearly 100 year history of Phoenix's water system, conservation has played an important role in ensuring safe, affordable, and reliable water supplies for its customers. Conservation became increasingly more important with the passage of Arizona's 1980 Groundwater Management Act, which was designed to reduce and ultimately eliminate dependency on pumped groundwater by cities, industry, and farms. In accordance with this legislation, the City of Phoenix has:

- Reduced per-capita water consumption (as previously discussed);
- Managed its distribution system to reduce lost and unaccounted for water below the regulatory standard of 10 percent;
- Limited water applied to golf courses, parks, and other turf-related facilities (at least 10 acres) to 4.9 AF/acre;
- Complied with the state requirement to use specified low water using plants in newly landscaped public rights-of-way;
- Limited the size of water features; and
- Prohibited the development of private lakes.

In 1990, the City adopted a plumbing code to support conservation efforts. This code, which was further reinforced by state and federal water-efficient plumbing standards in 1992, substantially supported the achievement of conservation goals. Phoenix's Water Conservation Plan and related initiatives have included:

- Retrofitting plumbing fixtures and repairing leaks in more than 130,000 older homes;
- Educating customers with regard to optimal water application, water system maintenance, xeriscape principles, and other landscape efficiency principles;
- On-site water efficiency audits for industrial and residential customers; Implementing educational programs such as Project WET (Water Education for Teachers);
- Demonstrating water and energy efficiencies in homes such as "Desert House" at the Desert Botanical Gardens, and in partnership with homebuilders, models within new subdivisions;
- In partnership with other Valley cities, developing the widely successful "Water—Use it Wisely" program to provide basic conservation tips via television, newspapers and other media. The success of this program locally, has led to its adoption in other markets, including Washington D.C., the State of Georgia, and the lower Puget Sound region in Washington State; and
- A comprehensive public awareness program administered though the Water Department's Public Information Office, which imparts water resources, drought and conservation information to customers by way of the award-winning WATERways video series on the City's television station, the Phoenix website, public speaking events, on-hold messages, school programs, water bill flyers, press contacts, and other venues.

In addition, Phoenix regularly collaborates with neighboring municipalities in developing and implementing effective regional conservation initiatives, which have served as models for other regions.

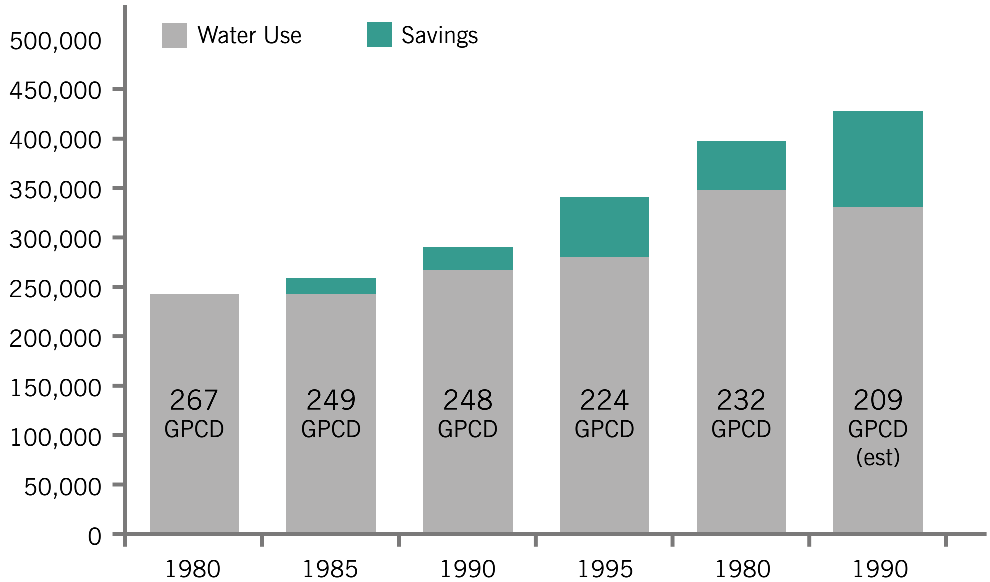


Figure 3-7. Estimated Water Savings based on 1980 Per-Capita Use Rate

DROUGHT AND WATER DEMAND

Drought Management (Response) Plan | Long-term conservation efforts and other water management strategies may not be sufficient to insulate the City from periodic drought impacts. Recognizing this, Phoenix became the first municipality in the state to adopt a comprehensive four-stage Drought Management Plan which was implemented over 10 years ago. Under the current Plan, Stage 1 may be declared when a major water supplier (such as SRP or CAP) announces reductions in available supplies. The responses called for a range of voluntary actions in the earlier stages to significant mandatory actions and reductions in Stage 4.

Stage 1 Conditions of 2003–2004 | SRP announced supply reductions for calendar year 2003 in late 2002, and the City resultingly declared “Stage 1” conditions. A public awareness campaign was launched, urging increased voluntary actions by customers. City departments were also mandated to cut water use as a whole by at least 5 percent. As a visible response, City golf courses and parks substantially reduced water consumption in 2003 and 2004, in part by eliminating winter turf overseeding. Customer water use also declined significantly, though increased precipitation at key points in these two years also contributed to the decline. Stage 1 conditions were lifted in April 2005 after a significant increase in reservoir storage following a wet 2004-2005 winter season.

During the recent Stage 1 conditions, reservoir storage in the Colorado River and Salt/Verde watersheds dropped to some of the lowest levels seen in decades. Although Colorado River storage dropped below 50 percent, there was still storage in lakes Mead and Powell, which prevented the need for a shortage declaration for Colorado River entitlements. As of late 2005, these reservoirs have rebounded somewhat, but are still low by historic standards. Though very low by historic standards, SRP reservoir conditions during the 2003-2004 period were aided by the purchase of significant quantities of excess CAP supplies by SRP for delivery to their customers. SRP also produced substantial groundwater to supplement surface water supplies.

Throughout the recent drought, Phoenix did not experience water supply shortfalls, though minor adjustments in water orders were needed. Effective management of supplies, Phoenix’s well-diversified water resources portfolio and conservation achievements over the years combined to prevent impacts to customer deliveries. However, growth and potentially worsening drought conditions in the future could lead to increased risks of shortfalls which could affect customers. The remainder of this Water Resources Plan addresses these risks.

CHAPTER IV
SCENARIO DEVELOPMENT AND EVALUATION

CHAPTER 4

SCENARIO DEVELOPMENT AND EVALUATION

Hildemann's Cereus

In 1951, following a decade of "unprecedented development," a report addressing future water production and transmission facilities for the City of Phoenix projected that the City's population would reach 420,000 by the year 2000. Almost fifty years later, the U.S. Census for 2000 established Phoenix's population at 1.3 million—a threefold increase over that seemingly robust 1951 projection (Figure 4-1).

Uncertainty regarding the rate of population growth is but one of the many challenges inherent in assessing the City's water needs over the next 50 years. An effective plan must consider not only the traditional "consensus opinion" of what is likely to happen over time, but a range of alternative scenarios which could occur. This 2005 update to the City's Water Resources Plan attempts to do just that, and in so doing, better prepares the City for a variety of potential outcomes. A strategic planning approach which considers a broad range of future conditions becomes particularly important in an era of over-allocated watersheds, concerns over long-term drought, more stringent environmental regulations, increasing water quality issues, litigation and tough competition for supplies.

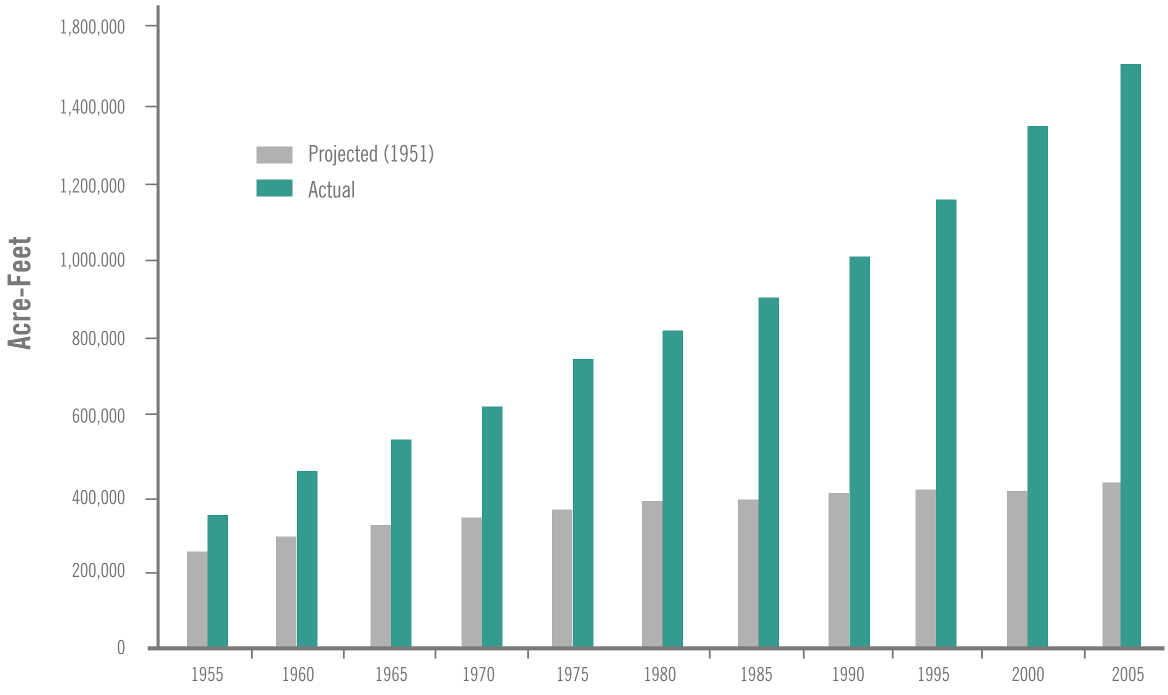
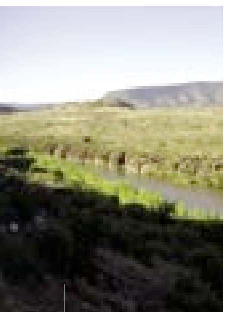


Figure 4-1 Projected versus Actual Population Growth, City of Phoenix, 1955-2005

PLANNING FOR UNCERTAINTIES | As the City looks to the future in determining the appropriate volume and combination of water supplies to meet customer demands, a number of questions arise. These questions highlight the uncertainties to be addressed in the planning process, and help provide insights and direction that will ultimately reduce the risk associated with future conditions. Some of these questions include the following:

Water Supplies:

- Is the past 100 years of record an appropriate indicator of future droughts (both length and severity) or should we be planning for potentially deeper and longer droughts as reflected in tree ring analyses covering several centuries?
- How soon are we likely to encounter shortages on the Colorado River and how severe are these shortages likely to be?
- How will Colorado River shortages affect CAP supplies allocated to Phoenix?
- What is the probability that SRP will need to reduce allocations beyond the roughly one-third cutback implemented in 2003 and 2004?
- What is the likelihood of drought on both of our major surface water systems at the same time?
- To what degree can we depend on groundwater to mitigate drought?
- Considering costs and relative probabilities, what is the optimal level of water supply and infrastructure redundancy needed to avoid adverse consequences to residents, businesses and the local economy?
- What mechanisms are most appropriate for recovering these costs?
- How will environmental regulations (e.g., Clean Water Act, ESA and SDWA compliance) affect futur water supply availability?
- To what degree can local water suppliers and wholesalers better collaborate to address challenges at a regional level?
- How will climate change affect water supply availability?



Verde River near Clarkdale

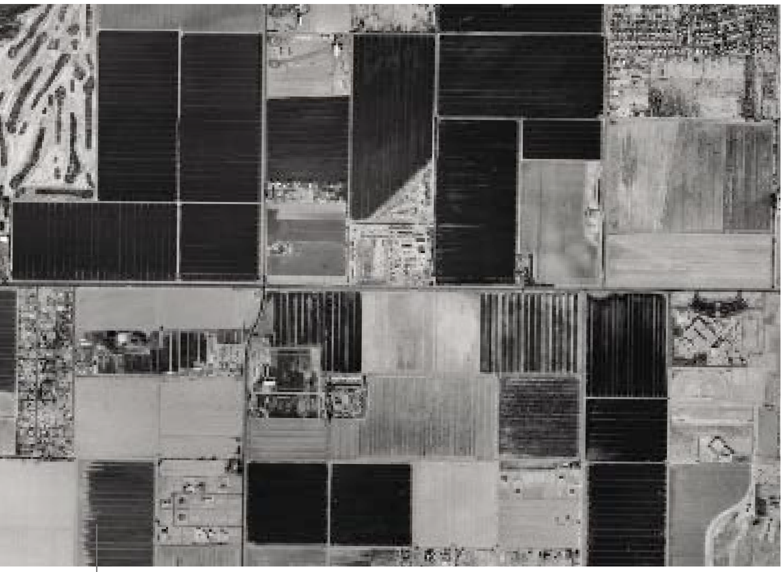
Growth and Water Demands:

- How could higher density development in Central Phoenix and elsewhere (over and above that described in the General Plan) affect our water demands? How will changes in the commercial/industrial makeup of our local economy affect water demands?
- How much further can customers conserve without adversely impacting lifestyle, the economy, and the overall "quality of life" in the community?
- How would shortages in SRP urban irrigation supplies (on-project) affect potable system demands?
- To what degree can customers be expected to reduce their demand in the event of a significant and protracted surface water shortfall?
- Under what conditions is it appropriate for the City to enact mandatory customer water use reductions?

These are examples of the questions the City has attempted to address through the development of water budget projection models, through which a wide variety of scenarios depicting the City's "water future" were evaluated. A representative selection of these scenarios will be presented in this Chapter.

Carefree Highway and I-17 **2000**

Carefree Highway and I-17 **2005**



51st Ave and Baseline **2000**

51st Ave and Baseline **2005**

MODELING APPROACH

Modeling occurred at the service area level, with distinctions made between the on-project and off-project areas. Efforts were also made to understand the spatial dynamics of supplies and demands within sub-areas or "demand zones" (described later in this chapter).

The key modeling steps involved:

- Identifying **key variables** which represent a broad range of "stories" which could develop over time
- Developing **water supply and demand profiles**
- Testing and evaluating sensitivity of the variables and profiles through **multiple scenarios**

This approach was intended to better define and understand the margin of error by assessing vulnerability to changing development patterns, water use patterns, drought and other factors.

KEY VARIABLES

Water supplies and demands are influenced by a mix of climatic, institutional, regulatory, economic and social factors. Within these influencers, numerous potential future "stories" can be identified—each with the potential to affect a different outcome. The process began by considering a variety of these stories (e.g. changing climatic conditions, changes in Phoenix's development trends, etc). With regard to water supplies, the stories were used to explain how selected water availability profiles (or outcomes) could develop. Each water right, contract and lease was evaluated in detail to understand the implications of various availability conditions. On the demand side, the stories led to the generation of alternative growth profiles which generated associated demand levels.

WATER SUPPLY AND DEMAND PROFILES

The following summary variables were selected as the most significant for use in modeling:

- Availability of supplies delivered by SRP
- Availability of CAP supplies
- Growth and development patterns
- Water conservation levels

Other considerations such as groundwater production capacity and reclaimed water availability were either fixed or correlated with the above variables.

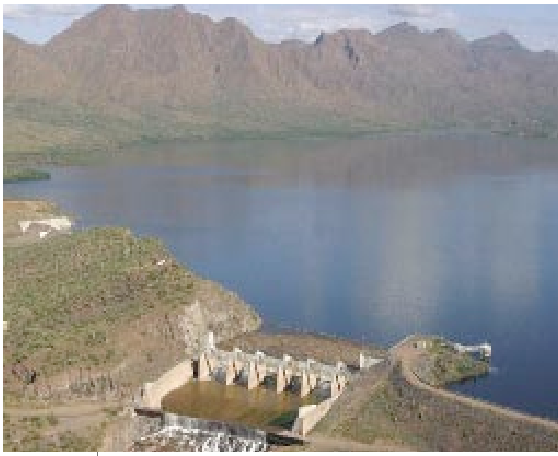
Salt River Project Supplies | The availability of SRP supplies is primarily tied to climatic and runoff conditions in the Salt and Verde river watersheds, and to SRP's ability to pump local groundwater. Storage capacity in reservoirs is about 2.3 million AF, and SRP well pumping capacity is about 340,000 AF per year. In a normal year, SRP delivers approximately one million AF per year. Over the past 10 years, approximately 20-25 percent of delivered SRP supplies was pumped from wells. Given the somewhat low volume of storage (relative to demands), the system is more sensitive to changing climatic and flow conditions. Other than extended periods of low inflows due to drought, threats to availability include environmental considerations (such as ESA mitigation), ongoing development in the upper and middle portions of the Verde River Watershed, and competing water rights claims.

SRP supplies were modeled at three levels: normal supply conditions, moderate shortage and severe shortage (Table 4-1). Under normal conditions, the City is entitled to 3 AF per acre of "stored and developed" water along with "normal flow" supplies (high-priority entitlements to pre-reservoir natural river flow). Normal flow supplies vary substantially from year to year, but a typical annual allocation based on demand of all member lands equates to 0.93 AF per acre.[8] The lowest figure on record (for 2002) equated to 0.64 AF per member land acre. Under normal year conditions, these SRP supplies available for on-project use in Phoenix range from roughly 336,000 AF in 2010 to 372,000 AF in 2055.

Moderate shortage reflects a one-third cut to the basic 3 acre-foot per acre "stored and developed" water allocation for all SRP shareholders. Normal flow availability was based on the lowest year on record (2002). The probability of moderate shortage conditions is somewhat low, though SRP has reduced the basic allocation to the 2 acre-foot per acre level twice since 1951 (most recently in 2003 and 2004). While SRP reservoirs filled in the winter of 2004-2005, continuation of the long-term drought cycle could result in a return to this "moderate shortage" level in the next 10 years. Under moderate shortage conditions, available supplies range from about 226,000 AF in 2010 to 251,000 AF in 2055.

Severe shortage reflects a roughly two-thirds cut in available SRP supplies with normal flow at historic low levels. However, because SRP maintains significant well capacity to supplement surface water supplies for normal operations and drought, the likelihood of shortages at this level are minimal. To further reduce this likelihood, SRP has begun an initiative to enhance well capacity. Under severe shortage conditions, available supplies range from about 141,000 AF in 2010 to 157,000 AF in 2055.

Horseshoe Lake,
Summer 2003



Horseshoe Lake,
Winter 2004-2005

[8]Normal Flow is entitled only to specific lands within the on-project area. For simplicity in projecting availability, a per-acre equivalent was applied to all SRP member land acreage. SRP maintains detailed accounting of eligible lands and related water use pursuant to a comprehensive "Water Delivery and Use Agreement" with the City.

TABLE 4-1 SRP ON-PROJECT SUPPLY AND DEMAND ESTIMATES

	2010	2015	2020	2025	2040	2055
On-Project Demand (AF):						
General Plan Level	198,000	206,000	214,000	218,000	224,000	224,000
High Density Scenario	212,000	241,000	278,000	301,000	374,000	382,000
On-Project Water Right Acres	85,000	90,000	94,000	94,000	94,000	94,000
On-Project Supply Availability (AF):						
Normal Supply Conditions	336,000	356,000	372,000	372,000	372,000	372,000
Moderate Shortage Conditions	226,000	240,000	251,000	251,000	251,000	251,000
Severe Shortage Conditions	141,000	150,000	157,000	157,000	157,000	157,000

Actual impacts to Phoenix from SRP shortfalls are highly dependent on demand levels in on-project areas in any given year. Currently, on-project demand ranges from 2.4 to 2.6 AF per water right acre (below "moderate drought" levels). For this reason, and due to the full availability of CAP supplies, there was no need to impose mandatory water use restrictions when the SRP Board reduced the allocation by one-third in September of 2002. However, increased on-project demand in the future due to higher density development (discussed in the next section) could bring usage to the limit of SRP availability. Thus, higher density development could increase vulnerability to SRP shortage conditions.

Deliveries for urban irrigation purposes (from SRP's non-potable system) would likely be affected in the event of surface water shortages. Because most urban irrigation customers also utilize water from the Phoenix system, demand for Phoenix water could actually increase under drought conditions. This factor must be evaluated and incorporated into Phoenix's drought management strategy.

SRP supplies are attached to specific lands in the Central Phoenix area. Unutilized supplies cannot be used outside of the SRP member land boundaries. These unutilized volumes remain in storage for the benefit of Phoenix and other SRP shareholders.

Availability of Gatewater, Roosevelt New Conservation Space (NCS) Water and Three-Way Exchange Water (involving RID/SRP/Phoenix) are dependent upon storage conditions in SRP reservoirs. For this reason, it was assumed that during both moderate and severe drought, these supplies were not available. Though it is possible that carryover credits from prior accruals may be available for use in shortage years, the elimination of these supplies under such conditions better reflects availability during extended drought.

Central Arizona Project Canal
west of Phoenix

Central Arizona Project Supplies | The availability of Phoenix's CAP supplies is tied to a number of climatic, regulatory, institutional and environmental considerations in the Colorado River watershed.

Total Colorado River system storage is approximately 62 million AF (with more than 50 million AF in lakes Powell and Mead). Sixteen and a half million AF is allocated among the seven Colorado River Basin states and Mexico. This allocation was based on flow conditions in the early 1900s which were, in retrospect, abnormally high. With flows in the last 50 years averaging 14.2 million AF per year , shortages are built into the system.

Though low flow conditions in recent years have reduced storage to approximately 50 percent of capacity, the likelihood of shortages are minimal in the next 10 years as Upper Basin demand, though increasing, will likely remain substantially below allocated volumes. The ultimate Upper Basin development levels are projected to range between 4.8 and 5.4 million AF per year,[9] and could be as high as 6 million AF per year. The high-end figure would significantly increase the risk and severity of shortages to Lower Basin states (and to CAP since this contract is the lowest priority on the system).

For modeling purposes, normal CAP supplies considered delivery of 1.5 million AF by the Project. Moderate shortage reduced availability to 1 million AF and severe shortage considered only 600,000 AF available. The probability of a "moderate" shortage rages from roughly 10 percent to more than 40 percent within the 50 year planning horizon, and is highly dependent on runoff, how the river system is operated, and the level of future development in the Upper Colorado River Basin states (i.e., the higher the level of Upper Basin development, the higher the probability of shortages to CAP).

CAP's lower priority status on the Colorado River exposes it to a high risk of severe shortage. This could include a complete loss of the entire 1.5 million acre-foot CAP allocation, although this is highly unlikely. Determining the probability and timing of such an occurrence is difficult, but it is clear that full development of allocations within the Basin, combined with a lengthy period of low flows (based on those seen in historic records) could result in this loss. However, there is an expectation at this time that a combination of reservoir operating guidelines, shortage criteria agreements, water banking arrangements and possible acquisition of higher-priority agricultural water rights will reduce the potential for severe shortage impacts to municipal CAP customers. Several of these efforts are currently proceeding with analytical support from the USBR, ADWR, CAP and various stakeholders.

Phoenix maintains a variety of contracts and leases for CAP supplies (as discussed in Chapter 3). These supplies do not all respond to shortages uniformly. As such, the characteristics of each were evaluated in detail, and factored into the forecasting process.

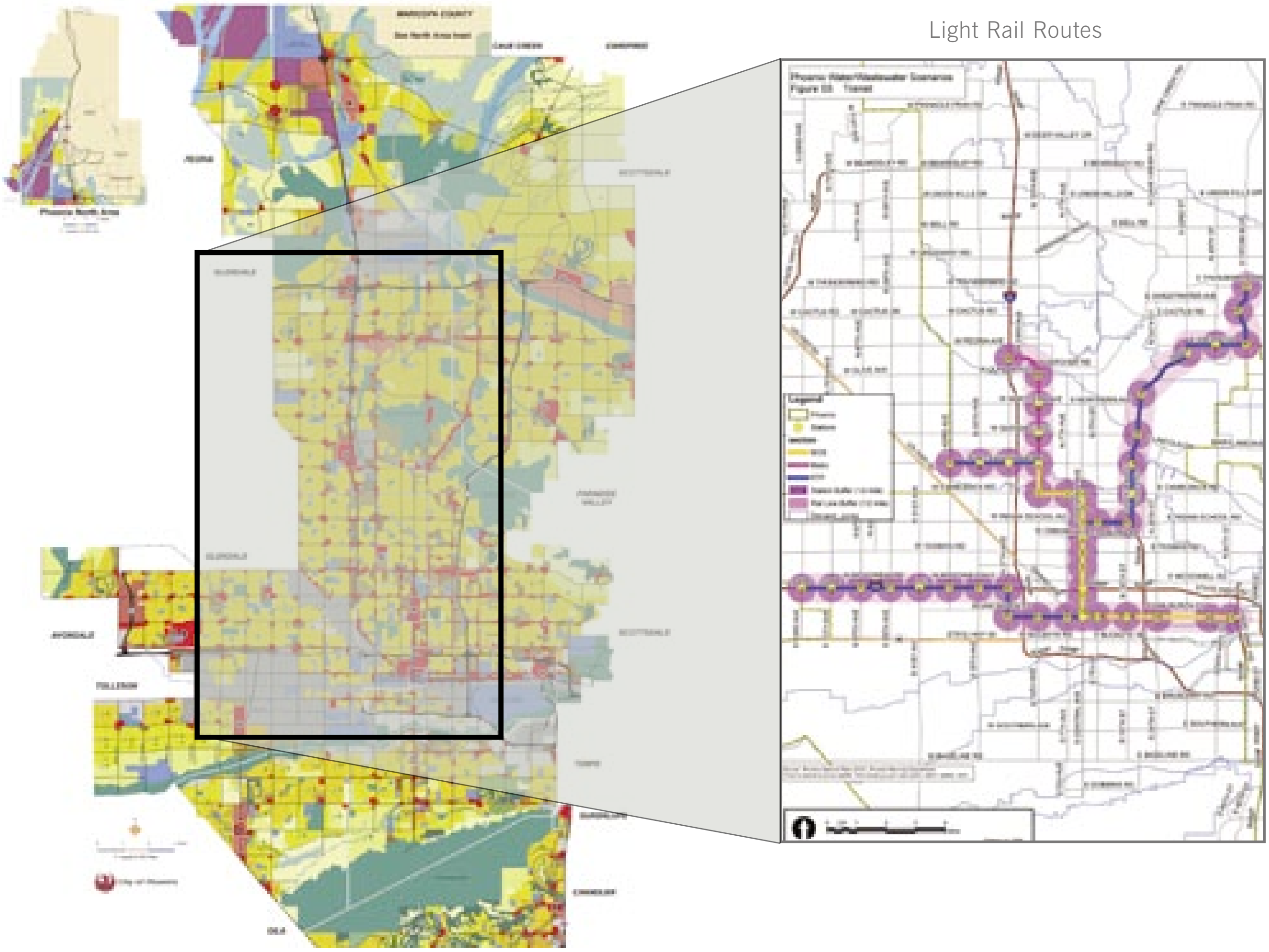
[9] *Based on Virgin flows at Lees Ferry (USGS and USBR)*

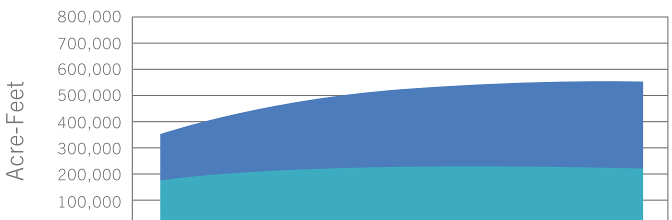
TABLE 4-1 OFF-PROJECT SUPPLY AND DEMAND ESTIMATES (Currently available supplies only)

	2010	2015	2020	2025	2040	2055
Off-Project Demand (AF):						
General Plan Level[10]	201,108	226,379	254,548	273,503	320,944	328,534
Off-Project Supplies - Normal Conditions (AF):						
CAP Supplies (all)[11]	186,000	186,000	186,000	186,000	183,000	186,000
SRP "Off-Project" supplies[12]	68,000	68,000	68,000	48,000	48,000	48,000
Reclaimed (deliverable in service area)[13]	5,000	5,000	5,000	5,000	5,000	5,000
Groundwater (sustainable volume)[14]	15,000	15,000	15,000	15,000	15,000	15,000
Total [15]	**274,000**	**274,000**	**274,000**	**254,000**	**251,000**	**254,000**
Off-Project Supplies - Moderate Shortage (AF):						
CAP Supplies (all)[16]	186,000	149,000	148,000	147,000	147,000	181,000
SRP "Off-Project" supplies	0 0	0	0	0	0	
Reclaimed (deliverable in service area)	5,000	5,000	5,000	5,000	5,000	5,000
Groundwater	15,000	44,000	44,000	44,000	44,000	44,000
Total	**206,000**	**198,000**	**197,000**	**196,000**	**196,000**	**230,000**
Off-Project Supplies—Severe Shortage (AF):						
CAP Supplies (all)[17]	107,000	106,000	106,000	102,000	100,000	118,000
SRP "Off-Project" supplies	0 0	0	0	0	0	
Reclaimed (deliverable in service area)	5,000	5,000	5,000	5,000	5,000	5,000
Groundwater	15,000	44,000	44,000	44,000	44,000	44,000
Total	**127,000**	**155,000**	**155,000**	**151,000**	**149,000**	**167,000**

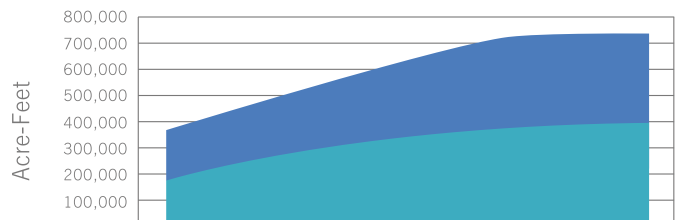
[10] High density scenario primarily impacts on-project lands, and thus was not included here.
[11] The increase in CAP in 2055 (in all scenarios) reflects the "firming" of the Hohokam ID water (which occurs in 2044). At that stage the water converts from a lower priority agricultural supply to a higher-priority M&I supply
[12] Includes Gatewater, Roosevelt NCS water and RID/SRP Exchange Water (all supplied through SRP). Assumed that under long-term drought shortage conditions, these supplies are not available as they rely on available reservoir storage.
[13] Assumed deliveries through North Phoenix Reclaimed Water Distribution System.
[14] Though the City has the current capacity to pump approximately 44,000 acre-feet per year (during drought or emergencies), the 15,000 AF estimate represents water "incidentally recharged" due to usage within the City.
[15] Supply figure declines between 2020 and 2025 due to assumption that the SRP/RID Exchange is no longer available (the reclaimed water would be available, though another mechanism for usage will need to be identified)
[16] Includes AWBA replacement for a portion of M&I subcontract CAP water lost due to Colorado River shortages
[17] Includes AWBA replacement for a portion of M&I subcontract CAP water lost due to Colorado River shortages

Growth and Development Patterns | Prior water planning efforts have looked to the City's General Plan and related population and housing unit projections developed by MAG as a basis for projecting demand (Figure 4-2). For this update, several alternative land development scenarios were developed. These scenarios considered an accelerated growth rate, changes in the type of economy, high density core areas in selected locations of the City, and high density in the central area (influenced by transit improvements). Most of these scenarios had only slight influences in water demands on a spatial and overall basis. However, the "central area high density" option generated the highest overall demand, and thus was used as the high-end scenario. The likelihood of development at this high-end level is considered low, though increased density levels are beginning to take shape in Central Phoenix. Details regarding the high-density scenario may be found in Appendix A.





	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055
Off-Project	173,372	201,108	226,379	254,548	273,503	293,770	307,206	320,944	323,593	326,107	328,534
On-Project	179,080	198,350	206,229	214,113	217,930	221,687	222,746	223,748	223,590	224,221	224,454



	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055
Off-Project	173,372	195,980	219,057	244,683	265,347	288,362	307,669	328,974	332,877	336,474	338,836
On-Project	179,080	212,455	241,162	278,462	301,218	327,020	349,511	374,284	378,325	381,891	382,263

Figure 4-2. City of Phoenix General Plan and Alternative High Density Land Use Scenario Demand Projections

Most of the increased demand in the "central area high density" option is within the area entitled to receive SRP water. Higher density development in this area would allow the City to utilize available SRP supplies to a greater extent, whereas if this same increase were to occur "off-project," other more expensive supplies would need to be accessed. However, increased densities on-project would also increase Phoenix's vulnerability to SRP system shortages.

Demands for both the "base" (General Plan) growth level and the "Central Area High Density" level were developed by applying sector-based water use factors to housing unit and non-residential acreage figures provided by MAG. The water use factors were derived by the City's Finance Department from records of billed water use from the years 1989 through 2000, and included a variety of both wet and dry years. Adjustments were made for lost water (typically in the 7 to 9 percent range).

Conservation | Three conservation levels were selected to assess the impact on supply acquisition needs:

- The "stable rate" level assumes no change to the basic rate of water use from a recent average (approximately 218 gallons per person per day) .
- The "trending" level assumes that Phoenix conservation efforts relative to new development meet the high-efficiency standards presented by ADWR in its Groundwater Management Plan. As much of the new development in Phoenix has been using water at a lower rate than older development, per-capita water use is decreasing. It is expected that this trend will continue, but could slow as the ratio of new homes to the number of total homes increases.
- The "aggressive" conservation level begins with the "trending" assumption and reduces water consumption of existing customers by an additional 10 percent.

It is important to note that reclaimed water availability was based on a percentage of total potable system water use. With increased levels of conservation, availability of reclaimed water will be reduced accordingly. Thus, from a water budgeting perspective, the net gains from conservation are partially offset by this loss of reclaimed water supply. Selected demand profiles are illustrated in Figure 4-3.

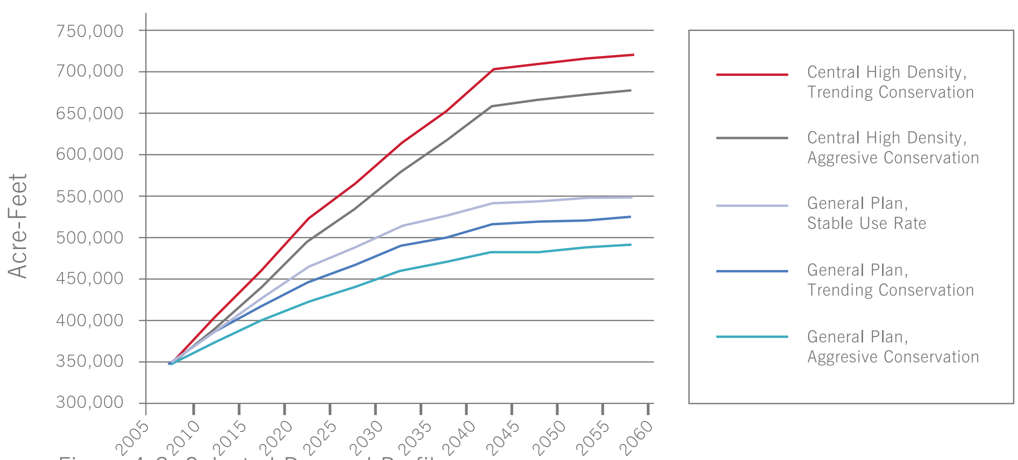


Figure 4-3. Selected Demand Profiles

OTHER CONSIDERATIONS

Tree Ring Research and Long Term Flow Records | Flow records for the Salt and Verde rivers and the Colorado River date back 100 years. However, the evaluation of tree rings allows for the development of simulated watershed flows over periods of 500 years or more. This information is valuable in determining the potential frequency and probability of long-term wet and dry cycles.

Recently, SRP (with Phoenix and the USBR as co-sponsors) partnered with the University of Arizona to determine the correlation of low-precipitation (and presumably low flow) conditions between the Salt, Verde and Colorado river watersheds based on flow reconstructions derived from tree rings.[18] The study and follow up evaluation point to a fairly high correlation (i.e., shortages occur simultaneously in both watersheds more often than not). In addition, a five-year running average developed from the study data points to at least three lengthy periods of low precipitation (Figure 4-4). This information is valuable in providing an understanding of how long droughts can extend. In evaluating this data in the context of the current dry cycle (which has covered the last 10 years), it is conceivable that these dry conditions could extend another twenty years or more (with occasional wet years interspersed).

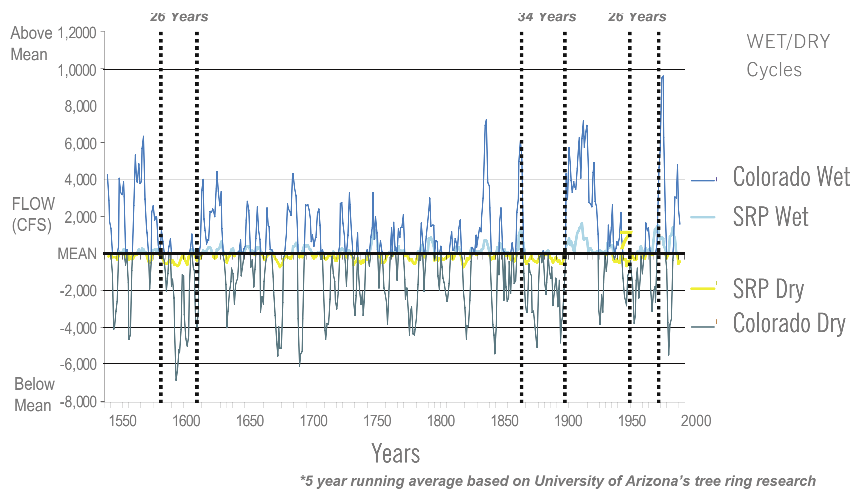


Figure 4-4. Colorado and Salt River Watersheds Reconstructed 500 Year Stream Flow Analysis

Global Warming Impacts | The impacts of global warming and potential climate change on watershed runoff have been considered in a number of research efforts. Researchers have projected increased long-term temperatures in source watersheds resulting in less precipitation. Most important would be a reduction in snowpack, leading to a reduction in the amount of water which is gradually released in the spring and summer months. Flow regimes would change with runoff occurring in more concentrated periods (i.e., there could be more frequent and severe lows and highs).

It is difficult to predict the exact impact of climate change on water supply availability in the Colorado, Salt and Verde river watersheds, and thus the modeling considered the potential indirectly. In effect, surface water shortages could in fact be triggered and/or lengthened as a result of global warming and climate change. It is not inconceivable that shortage periods could exceed those identified in tree-ring research, or that more frequent filling of reservoirs over shorter time spans can occur.

Urban Heat Island Impacts | With the documented gradual increase in average nighttime temperatures in Phoenix and surrounding areas due to urbanization, questions regarding the impact on water demand have risen. It can be speculated that if all other elements are held constant, water needed for outdoor uses and cooling purposes could increase. However, water for landscape purposes is still being overapplied despite efforts to increase efficiencies through conservation programs. In addition, current conservation efforts (as evidenced by declining per-capita consumption) and future conservation measures may more than offset any potential increases. Though quantification of the true impact of the heat island phenomenon was not attempted in this analysis, maintenance of a "stable" use rate through the 50-year planning horizon would more than cover potential increases in water needs. Basic assumptions used in the scenario profiles are summarized in Table 4-1.

[18] *A Tree-Ring Based Assessment of Synchronous Extreme Streamflow Episodes in the Upper Colorado & Salt-Verde-Tonto River Basins, Final Report, July 2005 A Collaborative Project between The University of Arizona's Laboratory of Tree-Ring Research & The Salt River Project Katherine K. Hirschboeck & David M. Meko, Laboratory of Tree-Ring Research, The University of Arizona*

TABLE 4-1 WATER SUPPLY AND DEMAND MODELING ASSUMPTIONS

WATER SUPPLY			
SRP Supplies	Normal conditions	Stored/developed allocation at 3 AF/acre, normal flow equivalent at .93 AF/acre[19]	Conditions expected more than 90 percent of the time
	Moderate Shortage	Stored/developed allocation at 2 AF/acre, normal flow equivalent at .64 AF/acre	Could occur several times over the 50 year planning horizon; potential for extended period in this range if long-term dry cycle materializes
	Severe Shortage	Stored/developed allocation at 1 AF/acre, normal flow equivalent at .64 AF/acre	Very low probability given SRP's expected ability to produce groundwater to replace a portion of the lost surface water.
CAP Supplies	Normal conditions	1.5 million AF available to CAP[20]	Conditions expected 60 to 90 percent of the time
	Moderate Shortage	1 million AF available to CAP (500,000 acre-foot cut)	Could occur in 10 to 40 percent of the planning period (dependent on upper basin development, reservoir operation protocol and shortage sharing agreements)
	Severe Shortage	600,000 AF available to CAP (900,000 acre-foot cut)	Expected to be very low probability (dependent on upper basin development, reservoir operation protocol and shortage criteria).
Groundwater	Assumed approximately 44,000 AF per year is available (based on current well capacity) with an additional 30,000 to 50,000 AF available in the future (based on expanded well capacity)		
Reclaimed Water	Assumed up to 5,000 AF for deliveries from CCWRP.[21] Future availability of effluent assumes 35 percent of potable system supplies (less commitments to the Palo Verde Nuclear Generating Facility, BIC, Tres Rios); Assumes RID Exchange phases out by 2025.		
McMullen Valley Groundwater	Assume available for redundancy/drought backup by 2020 (with wheeling agreement in place)		

WATER DEMAND		
Development	General Plan (Base)	Utilized General Plan-based 2003 MAG projections (adopted for period through 2030). Unofficial and interpolated/extrapolated figures used period through 2055
	Central Area High Density	Densities increased predominantly in central Phoenix
Conservation	Stable Rate	Current rate of water use (i.e., today's average gallon per person per day rate)
	Trending Rate	Assumes a downward trend in per-capita consumption resulting from higher efficiencies in new development
	Aggressive	An additional 10 percent reduction is applied to existing (2005) water customers (uses the "Trending" scenario as a starting point)

[19] In some surplus years the stored/developed availability may exceed 3 AF/AC
[20] CAP may divert 1.8 million AF per year based on its existing infrastructure and when Colorado River supplies are available.
[21] North Phoenix Reclaimed Water Distribution Master Plan, January 2004

SELECTED SCENARIOS

Initial modeling efforts led to the development of 144 scenarios with varying combinations of supply and demand factors. By reducing the number of shortage and growth levels, 54 scenarios remained. Out of these 54, six representative scenarios (A through F below) are presented in this Update. For each of these scenarios, an aggressive conservation version is also presented for comparison purposes.

The presented scenarios are as follows:

SCENARIO	SUPPLY AVAILABILITY CONDITIONS	DEMAND/GROWTH LEVEL
A	Normal supply	Base (General Plan)
B	Normal supply	Central Core High Density
C	Moderate Shortage	Base (General Plan)
D	Moderate Shortage	Central Core High Density
E	Severe Shortage	Base (General Plan)
F	Severe Shortage	Central Core High Density

Additional background information for these scenarios is summarized below.

Availability Conditions

- "Current supplies" are those that are available for delivery to customers (or will be in the next few years). Reallocated M&I CAP water (8,206 AF per year) and the lease of Indian CAP from the GRIC (15,000 AF) are considered in the "current" category though the actual transactions to obtain them have not been completed.
- "Future supplies" are those in which the City maintains title, or are otherwise expected to be available to the City.
- "Future supplies" include additional groundwater and recovered water made available through well capacity expansion, McMullen Valley groundwater, uncommitted reclaimed water and a 12,000 acre-foot block of M&I priority CAP water allocated to the State Land Department which is tied to state lands in North Phoenix.

Availability Conditions (continued)

- “Supplemental supplies” are those which the City will need to acquire to “supplement” current and future supplies—primarily to mitigate drought conditions. A potential supplemental supply would be dry-year fallowing agreements entered into with farmers that have higher-priority supplies. During surface water shortages, Phoenix would receive water which would have otherwise been used for farming.
- “Drought Response” as used in the scenarios refers to the need for deployment of supplemental supplies and/or demand reduction measures when a combination of current and future supplies is insufficient to meet demands in any given year.
- Based on the University of Arizona’s tree ring research findings (discussed earlier), the SRP and Colorado systems are assumed to experience normal and shortage conditions in tandem.

Demand Levels

- SRP supplies are demand-constrained (i.e., available SRP supplies currently exist in excess of that needed for on-project demands). However, in the high-density scenario, more of this water can be used. Thus, the current supplies expand based on this increased on-project demand.
- Current customer demand is approximately 350,000 AF. This amount is used to evaluate scenarios including the impacts to current customers. The intent is to guide an appropriate allocation of water acquisition and infrastructure costs among current customers and new development.

Conservation Levels

- The stable rate provides a conservative water use representation for the general plan scenario as it is likely that the per-capita consumption will decline (though more slowly as new development becomes a higher percentage of overall residential usage).
- The “trending” conservation option was applied to the high density analyses as per-capita needs for landscape watering will be less than under the general plan option.
- To better understand the impact of aggressive conservation, this level is applied to each of the six scenarios as an alternative. It is important to note that the net water savings from conservation are partially offset by reductions in wastewater flows, and thus reclaimed water. In addition, SRP water “saved” under normal conditions would remain in storage for future use by all SRP shareholders, including Phoenix.

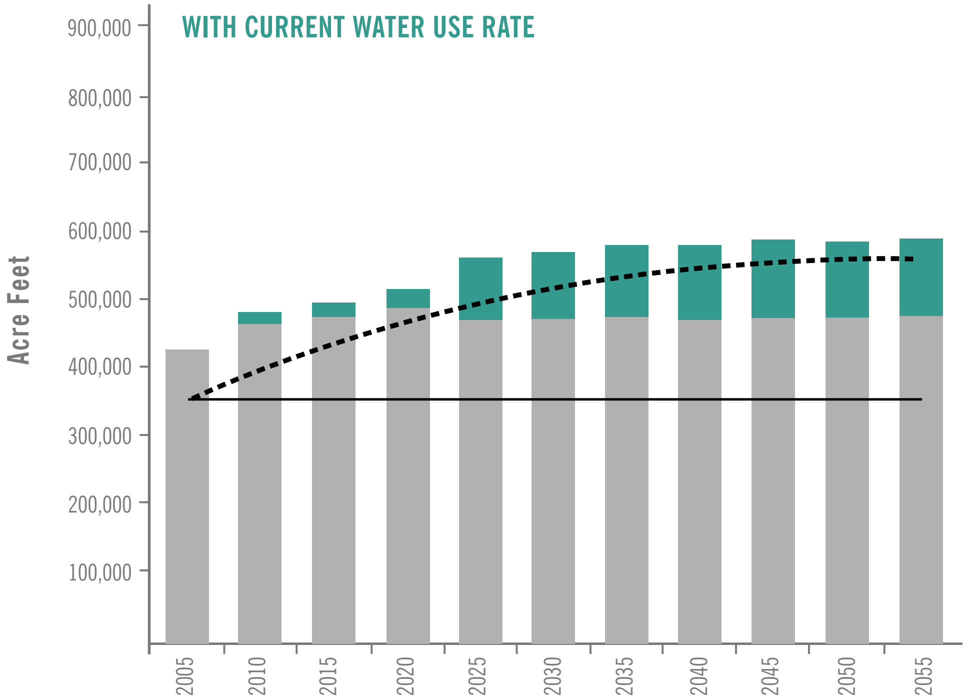
Other Considerations | The scenarios depict the water balance for any year in which a given set of conditions is simulated. It should not be assumed that we would encounter 50 consecutive years of any one set of conditions. Each bar is merely a representation of what might be expected if stated conditions were to exist in that year.

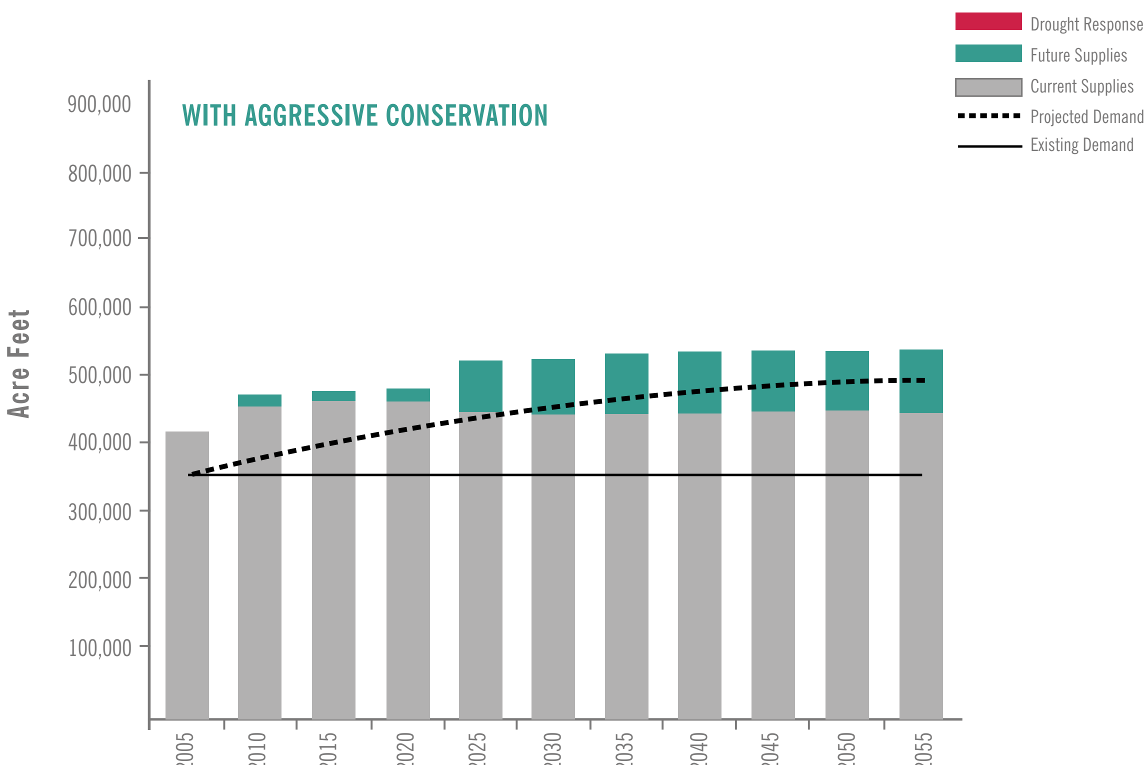
Details for these scenarios may be found in Appendix B.

SCENARIO A:

Normal Supply Conditions

General Plan Growth

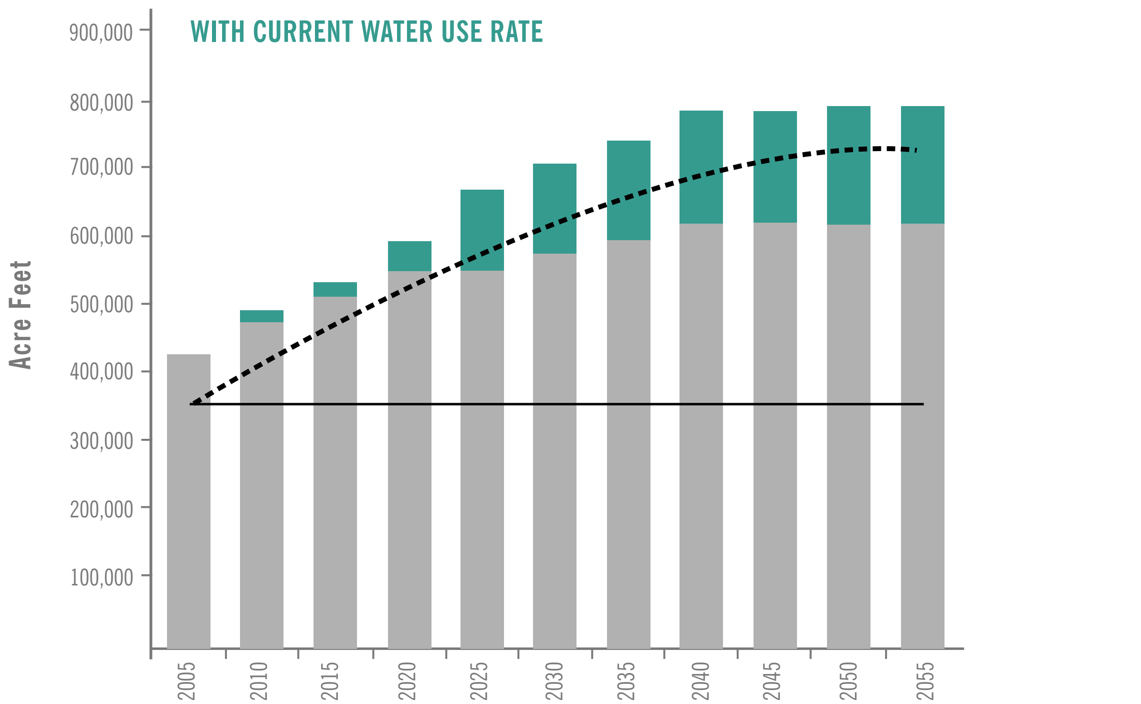


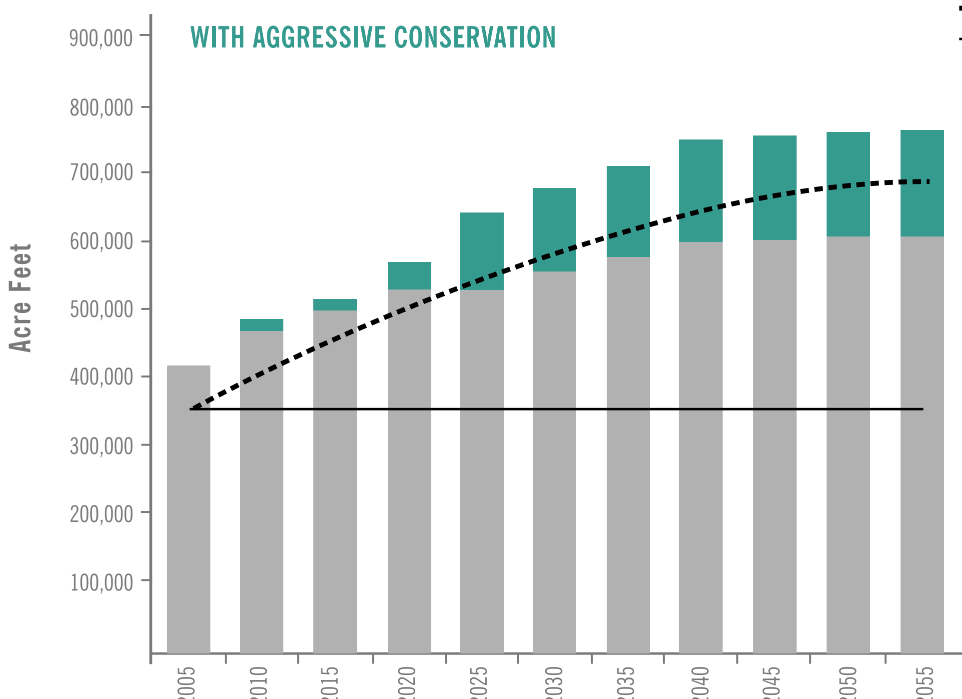


SCENARIO B:

Normal Supply Conditions

High Density Growth

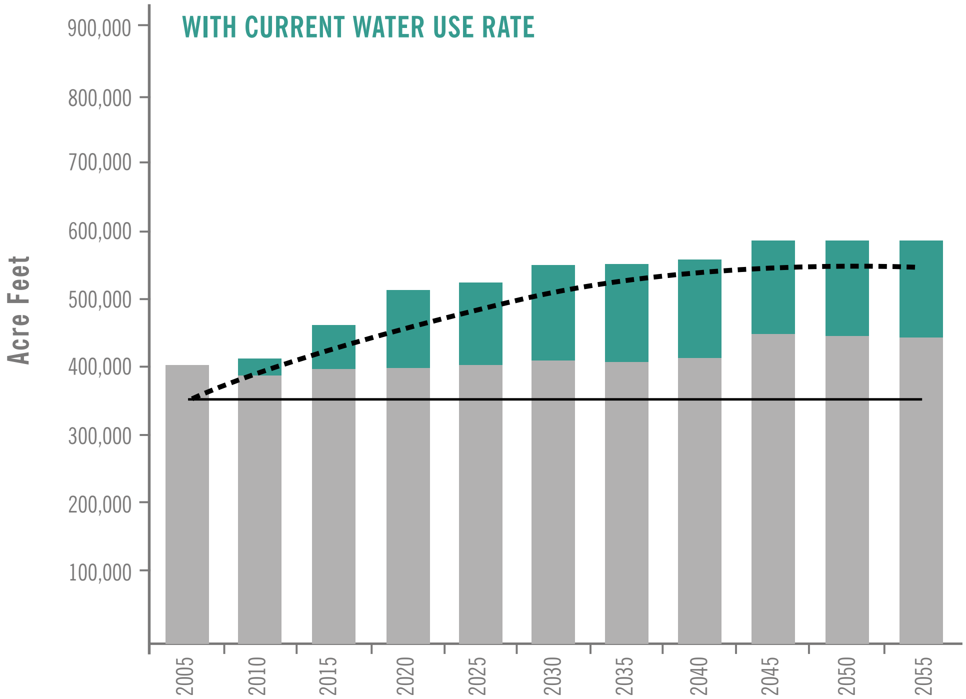


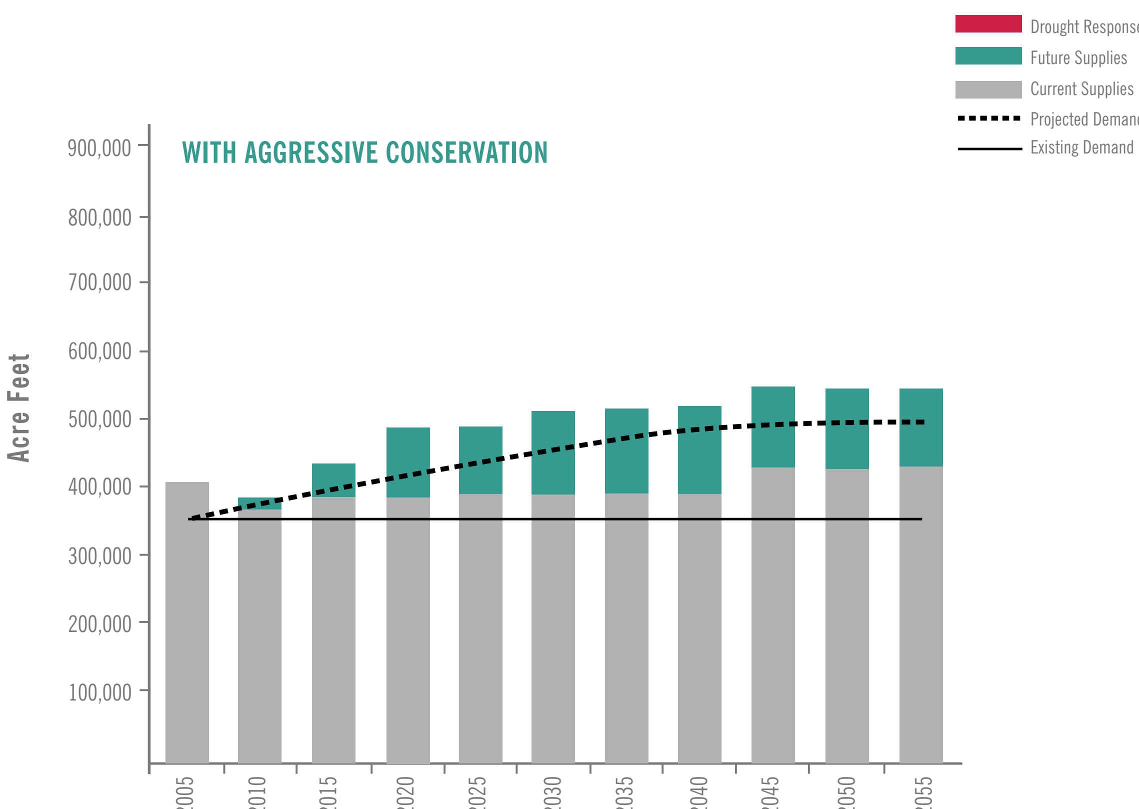


SCENARIO C:

Moderate Shortage Conditions

General Plan Growth





SCENARIO D:

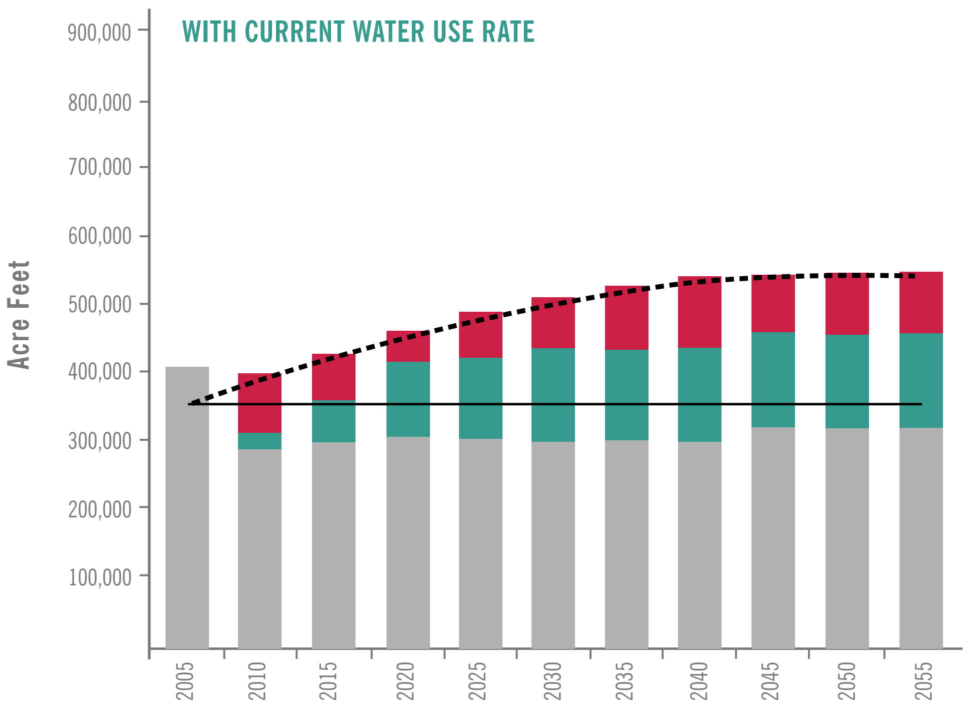
Moderate Shortage Conditions

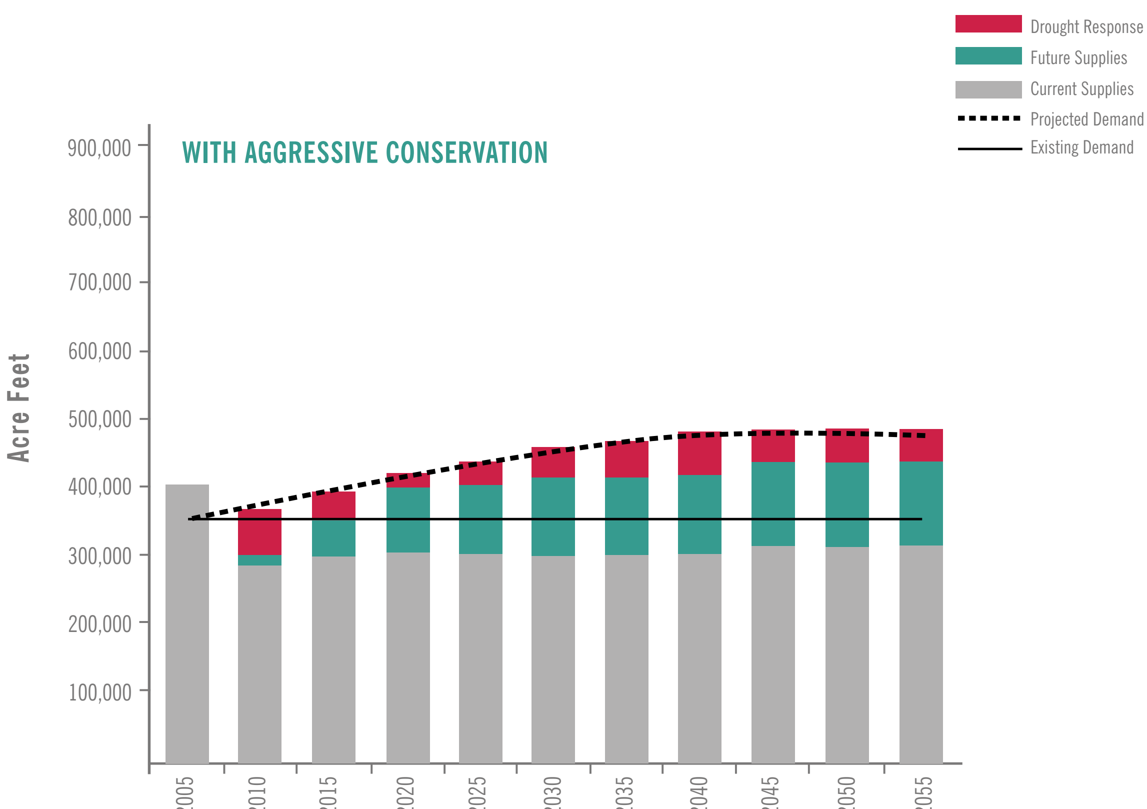
High Density Growth

SCENARIO E

Severe Shortage Conditions

General Plan Growth

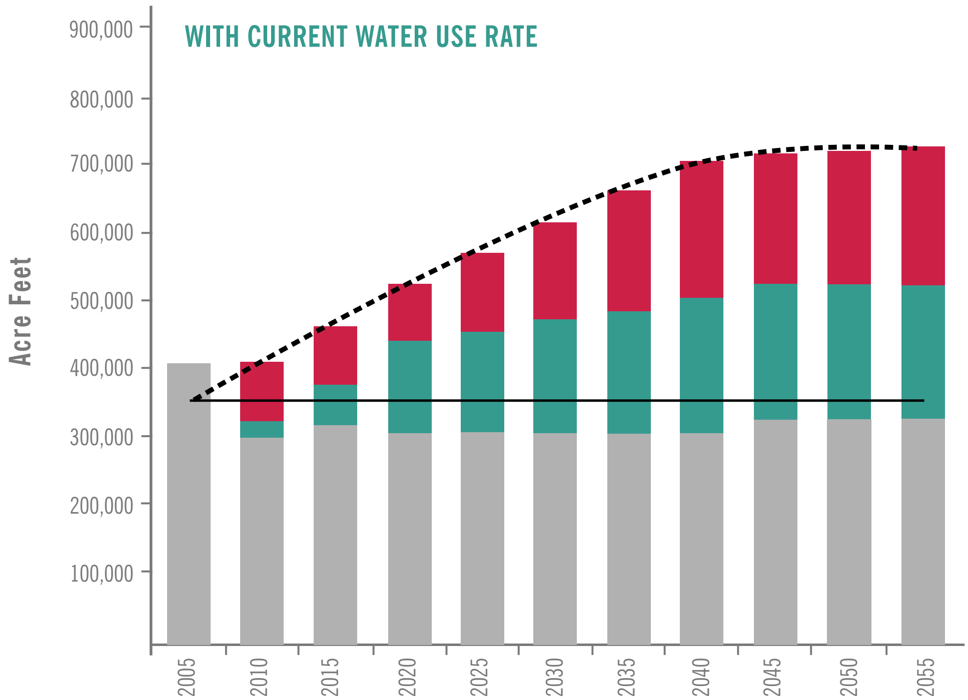


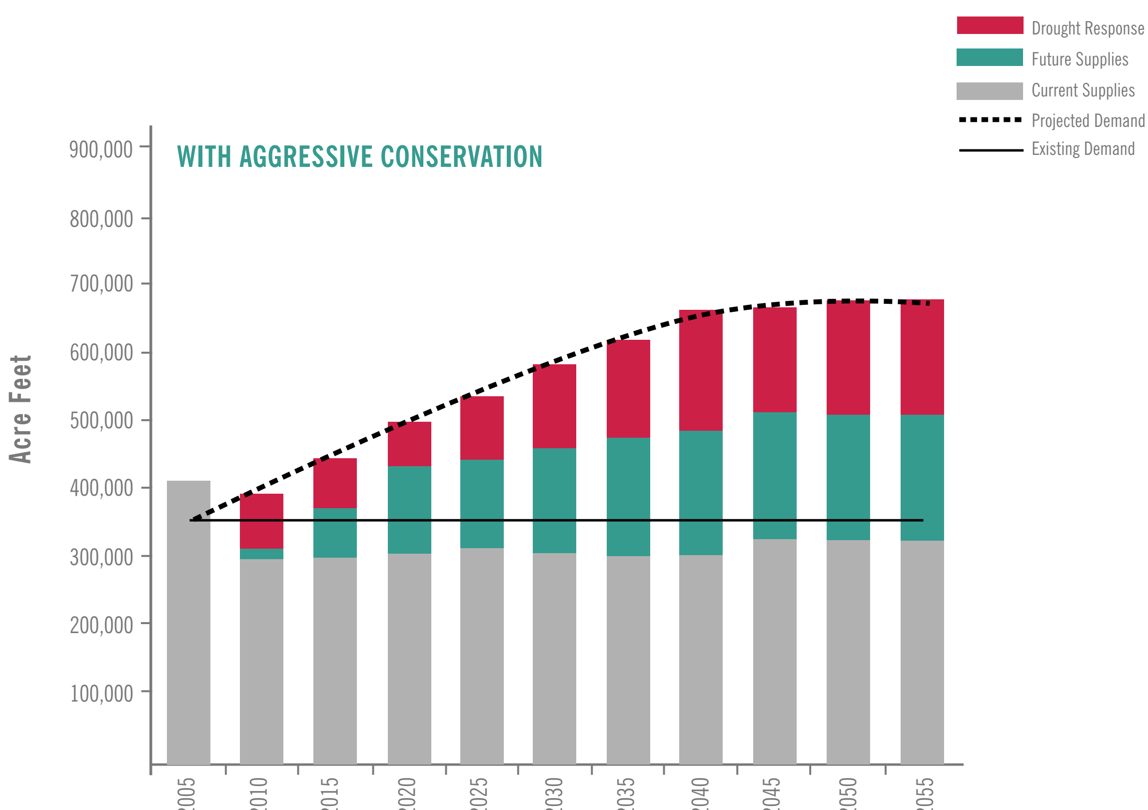


SCENARIO F

Severe Shortage Conditions

High Density Growth





CONCLUSIONS | In evaluating the scenarios, several conclusions were derived:

- **Existing customer demands can be met under both normal and moderate shortage conditions for the entire 50 year period.**

  If Phoenix demand was to stabilize at current levels, no further capital expenditures would be necessary for water supply acquisition and for the development of related infrastructure. Even under severe shortage conditions (which are likely to be very infrequent), existing customers could adapt by reducing water use by approximately 10 percent for the duration of the severe shortage.

- **Projected demands under both base (General Plan) and high-density development levels can be met with a combination of current and future supplies in both normal and moderate shortage conditions for the entire 50 year period.**

  This conclusion assumes that all current and future supplies are available for service to customers. Under high-density conditions, a potential gap of up to 10 percent may exist under moderate shortage conditions beginning in 2030, though increased conservation, lower than expected use rates or relatively minor drought-based demand reductions would eliminate this gap.

- **Under severe drought conditions, a combination of customer demand reductions and supplemental supplies would become necessary.**

  The most significant needs would occur in the high-density scenario where a nearly 30 percent gap could develop between supplies and demands. This gap could be achievable on a short term (1-2 year) basis with demand reductions alone. Extended severe conditions (which are highly unlikely) would necessitate deployment of supplemental supplies.

- **Deployment of future and supplemental supplies will entail significant capital expenditures to be phased in over time.**

  Plans for deploying these supplies will need to be developed. Costs will be incurred for supply acquisition, the drilling of new wells, wellhead treatment facilities, reclaimed water treatment facilities, transmission lines, recharge facilities and a host of other related features.

Lake Pleasant Water Treatment Plant

SENSITIVITY TO EITHER SRP OR CAP SHORTAGES

Additional evaluation of the 144 total scenario combinations yielded further insights with regard to Phoenix's sensitivity to SRP shortages versus CAP shortages. As an example, it was discovered that the impact of severe Colorado River/CAP shortages is substantially reduced when SRP supplies are considered "normal" (Figure 4-5). This is largely due to the following model assumptions:

- Gatewater, Roosevelt NCS Water and Three-way Exchange Water (the availability of which is tied to SRP reservoir conditions) are allocated to meet off-project demands in place of the lost CAP supplies.
- Water stored by the AWBA will be available (via the CAP canal) in a volume sufficient to offset 20 percent of the lost CAP supply (municipal subcontract portion only)
- SRP "Stored and Developed" supplies and Normal Flow supplies are sufficient to meet on-project demands under both the General Plan and High Density growth scenarios

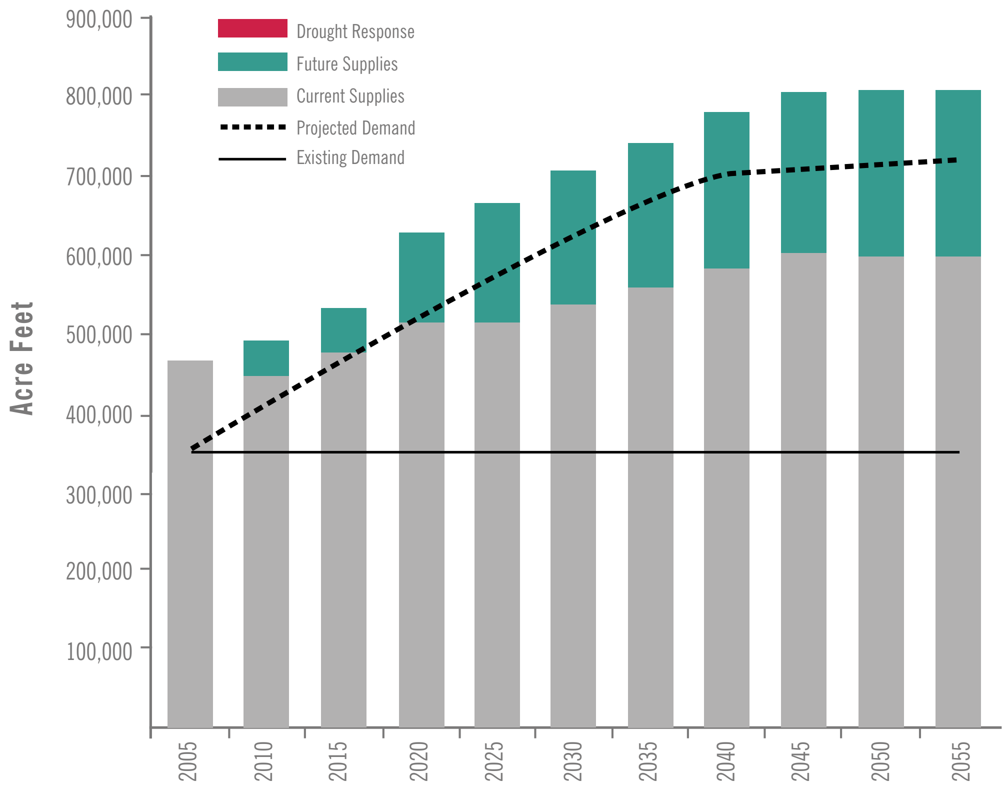


Figure 4-5. Normal SRP supplies, severe CAP shortage and high density growth

A combination of normal CAP supplies and severe shortage on the SRP system yields a much different result (Figure 4-6). If this scenario were to occur in any of the projection years, future supplies would need to be deployed, as well as supplemental supplies beginning in 2025 or 2030. However, it should be noted that severe shortage on the SRP system is highly unlikely if SRP maintains its current backup groundwater production capacity.

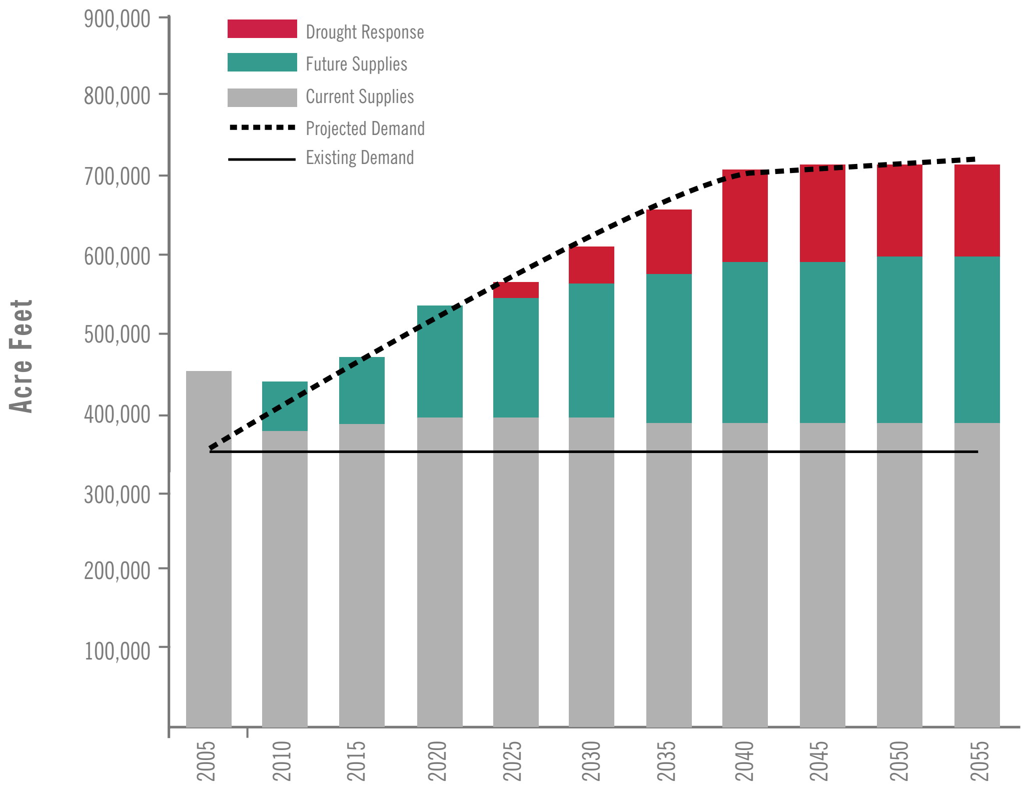


Figure 4-6. Normal CAP supplies, severe SRP shortage and high density growth

DEMAND ZONE ANALYSIS—DROUGHT SIMULATION MODEL

Model Development | This 2005 Water Resources Plan Update primarily addresses water supply availability at the service area scale. However, a need for further investigation was identified to address the spatial impacts of supply shortages. For example, due to the location of water treatment plants, wells and major transmission mains, certain parts of the service area have more flexibility (and thus less drought vulnerability) than other areas. To better understand these spatial impacts of surface water shortfalls, a Drought Simulation Model was developed early in the planning process. Efforts and information behind this model were instrumental in developing the service area-wide portfolio analyses presented earlier in this chapter.

The intent of this more detailed modeling effort was to identify potential infrastructure-related restrictions associated with meeting customer needs within twelve demand zones (Figure 4-7). Demand zones are geographic areas of relatively uniform service conditions (e.g. land surface elevation, water pressure, access to water treatment plants). The detailed model evaluated projected monthly demands (based on General Plan and high-density projections) and supply availability for each zone. Supply availability considered water deliveries to treatment plants and between zones under a number of water shortage scenarios and operating rules. The ultimate purpose of the model is to identify and quantify potential surface water shortfalls within demand zones under a variety of conditions.

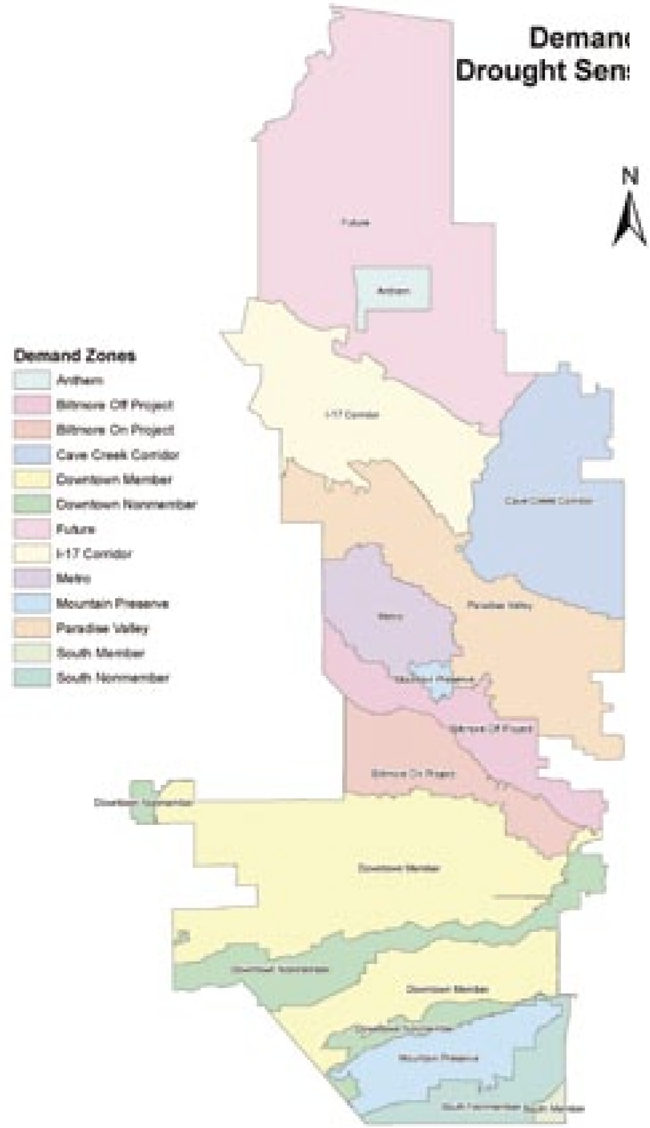


Figure 4-7. Drought Simulation Model Demand Zones

Initial Results and Conclusions | Evaluation of model output demonstrates that potential water supply shortfalls may occur in selected demand zones under moderate to extreme shortage scenarios. Preliminary results indicate that many of these zone shortfalls could be addressed by changes in plant and system operation, though some scenarios may dictate a need for additional local supply. A key area where such backup capacity will be focused is the higher density areas of Central Phoenix where a large number of wells were removed from service due to groundwater contamination.

In general, this modeling helps underscore that on an overall basis, the City has access to sufficient current and future water rights, allocations and leases to meet customer demand under most foreseeable surface water shortage conditions. However, access to this water may be impeded by lack of sufficient well production capacity, treatment facilities and transmission capacity.

Continued analysis of the output and refinement of system operation criteria will be necessary to derive more specific water system capacity enhancements. This will occur in conjunction with the approaches discussed in Chapter 6.

CHAPTER V
STRATEGIC CONCEPTS

CHAPTER 5

STRATEGIC CONCEPTS

Argentine Hedgehog

The six scenarios presented in Chapter 4 identify possible outcomes under specified water supply and demand assumptions. Key next steps in the planning process include: 1) assessing the probability of these outcomes in any given year (with emphasis on the short term); and 2) establishing strategic concepts to guide further evaluation and implementation. This chapter will focus on these next steps.

PLANNING TIMELINES

For each scenario, probabilities for each projection year were considered in the context of current water supply conditions, demand trends and other relevant factors. Using this evaluation, timelines were developed with the assumption that the region is currently in the early stages of a long-term drought. Historic records illustrate dry periods between 20 and 40 years duration, within which occasional wet years (such as the winter of 2004-2005) occur. Some climatologists assert that the region may currently be within such a period.

With this assumption, it can be expected that Phoenix will experience normal supply conditions for approximately 10 years (through 2015). This expectation of normal conditions is based on several factors: 1) Modeling results for the Upper Colorado River Basin, and demand patterns within Arizona, do not anticipate shortage to Phoenix over this 10-year period; 2) SRP reservoirs filled during the winter of 2004-2005, and are likely to support normal deliveries for several years; and 3) any increases in development densities within on-project areas would not be sufficient to substantially impact increased use of SRP supplies (on an acre-foot per acre basis) in this time frame.

If dry conditions (i.e., below normal runoff levels) exist in the time period and continue beyond 2015, it is probable that the region could experience moderate shortages after that time. Low reservoir levels and increasing build-up in Colorado River demands would characterize this phase. Extended dry conditions could ultimately lead to severe shortages. Planning timeline charts illustrating the timing of these potential conditions (normal, moderate shortage and severe shortage) are presented in Figures 5-1 and 5-2.

This view of potential shortage conditions, especially over the next 10 to 20 years, is of value in planning and scheduling water infrastructure improvements. For example, the timelines point to a need for the deployment of "future supplies" by 2015. Thus, supply selection, project design, capital budgeting and construction activities must occur within this ten-year period.

PLANNING TIMELINES

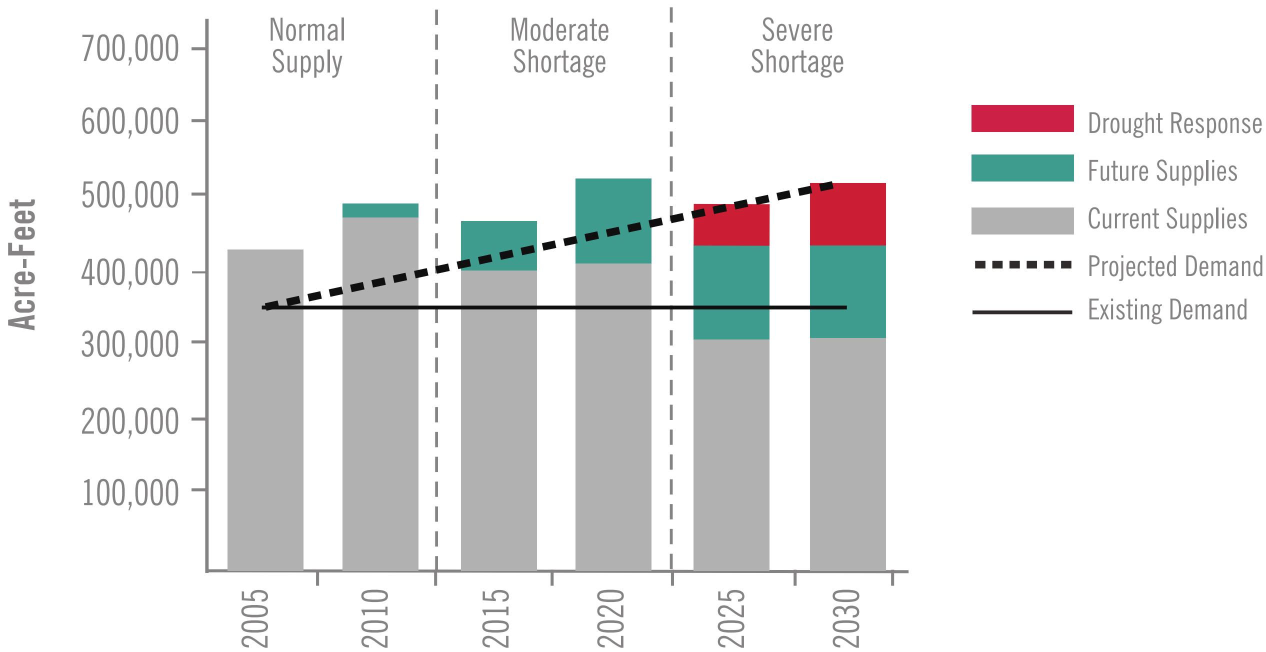


Figure 5-1. Conceptual planning timeline base (general plan) growth profile

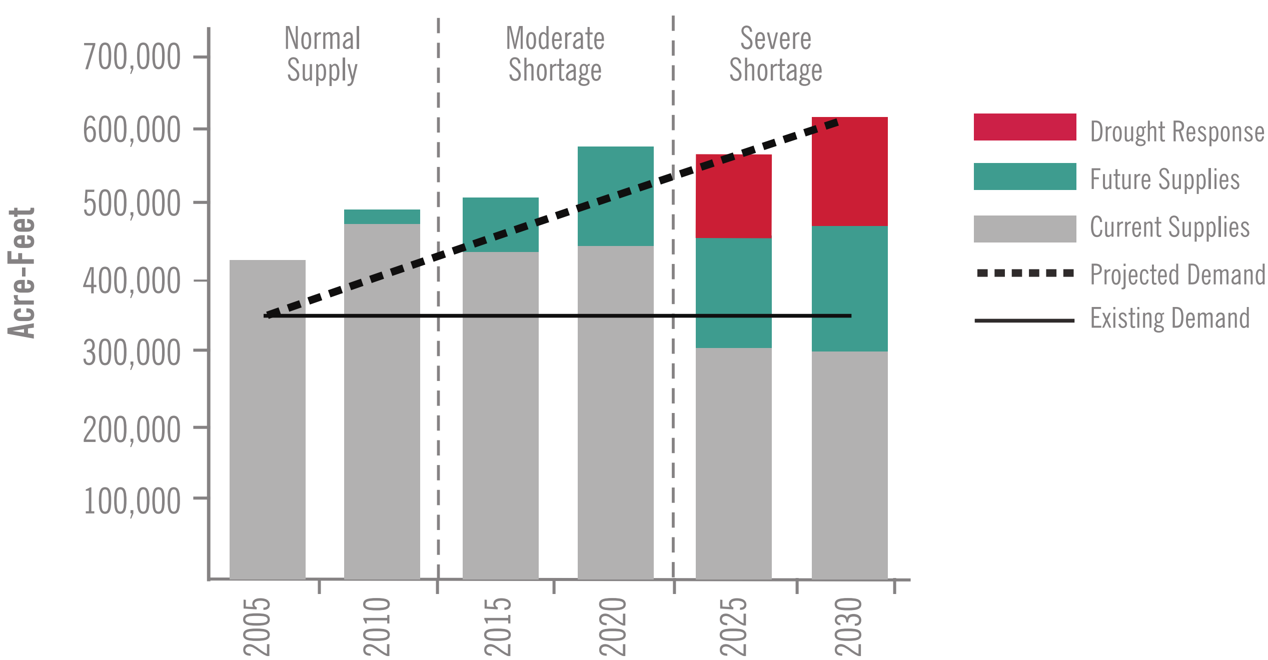
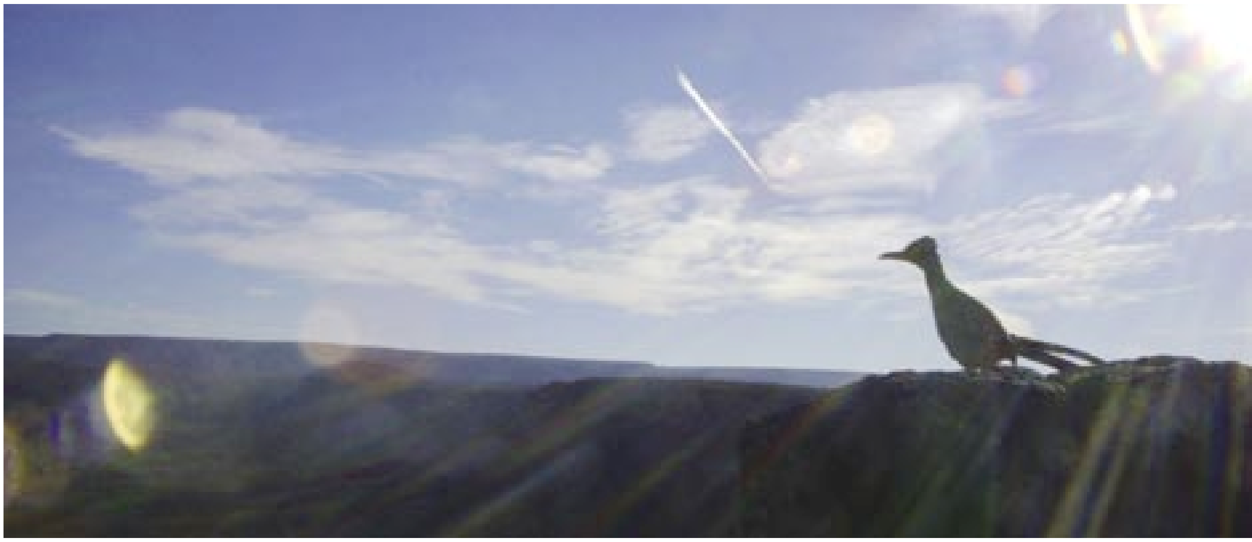


Figure 5-2. Conceptual planning timeline high density growth profile



STRATEGIC CONCEPTS

From the planning timelines and related information developed in the planning process, twelve basic strategic concepts emerge. These concepts provide direction and focus to ultimate implementation actions (discussed in Chapter 6). The concepts are as follows:

- Develop supplies sufficient to target both “base growth” and “high-density growth” demands under normal conditions and moderate shortages;
- Begin deployment of “future” supplies by 2015 to meet growth demands under moderate drought conditions;
- Continue phased deployment of “future” and “supplemental” supplies beyond 2015 to meet growth demands under normal, moderate and severe-drought conditions;
- Consider cost, reliability, accessibility, and maintenance needs in selecting the appropriate mix of future supplies for deployment;
- Funding for the deployment of future and supplemental supplies should be derived from growth-related revenues;
- Promote enhanced conservation to minimize drought impacts to customers;
- Manage groundwater supplies for aquifer sustainability;
- Maximize utilization of reclaimed water;
- Enhance water quality and match with appropriate uses;
- Consider environmental benefits and costs in the analysis of water supply and demand management efforts;
- Pursue opportunities for supplemental water supplies and demand reduction measures that could be deployed during extreme drought; and
- Promote regional cooperation in deployment of drought supplies and strategies.

Concept 1 | Develop supplies sufficient to target both "base growth" and "high-density growth" demands under normal conditions and moderate shortages.

Based on past population projections (which have typically underestimated growth), the General Plan projection may be considered low. Though the divergence between this projection and the high-density level intensifies over time, periodic reevaluation of trends will presumably allow for a narrowing of the projection gap (Figure 5-3).

Demands should also include additional needs arising from shortfalls in non-potable supplies due to drought-related shortages or infrastructure malfunctions. The shifting of demands from non-potable systems to the potable system could occur as a result of shortfalls on the SRP urban irrigation system or the reclaimed water system.

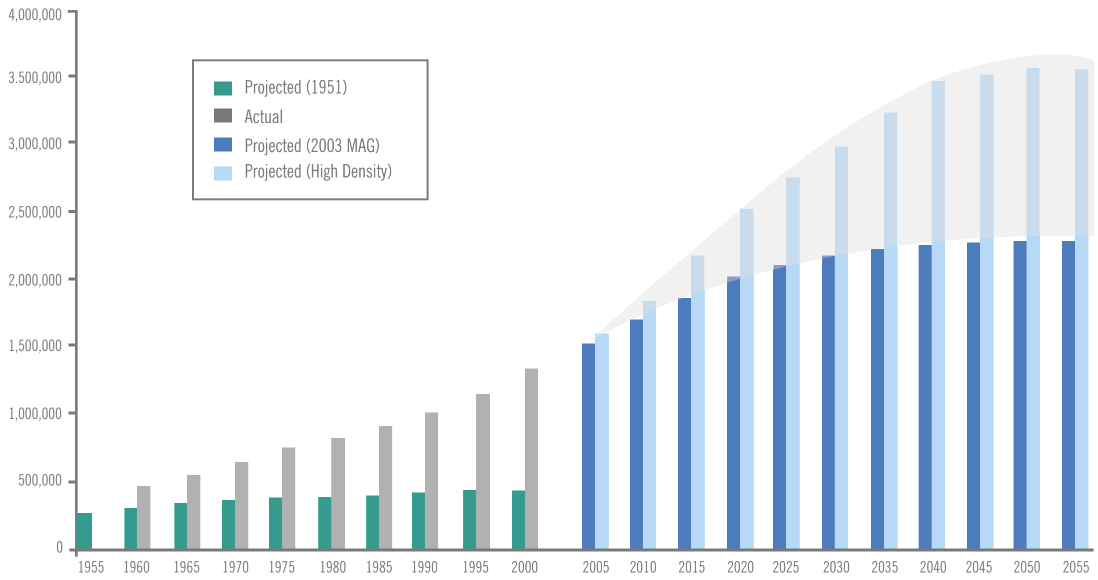


Figure 5-3. Range of Population Projections

Concept 2 | Begin deployment of "future" supplies by 2015 to meet growth demands under moderate drought conditions.

On the basis of the planning timelines, a portion of the "future" supplies will need to be active by 2015. At this early stage of the 50-year window, the divergence between the General Plan and High Density growth scenarios is minimal (Figure 5-4). Thus, a common supply deployment strategy could address both projection levels. Utilization of these supplies may also become necessary for operational flexibility, to meet peak demands and to better manage emergencies. These needs may be more urgent than drought-related requirements.

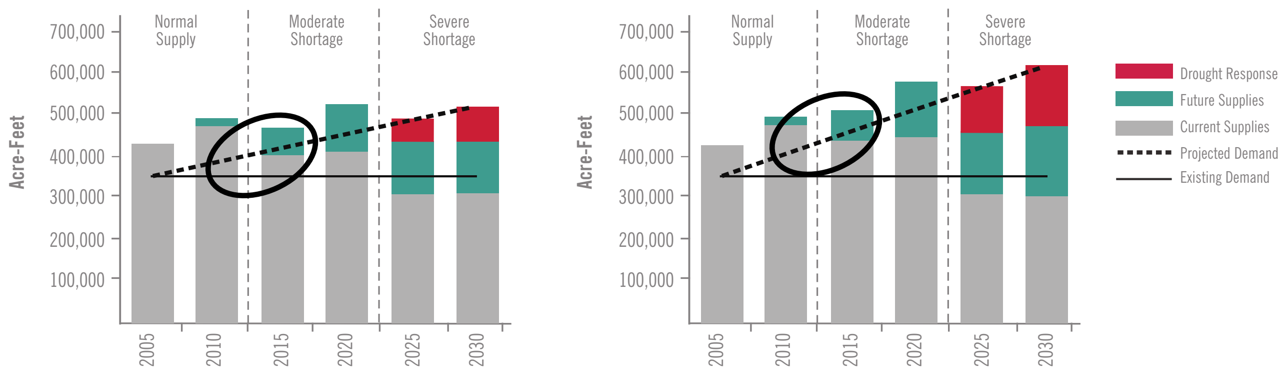


Figure 5-4. Planning for Moderate Shortages by 2015

Concept 3 | Continue phased deployment of "future" and "supplemental" supplies beyond 2015 to meet growth demands under normal, moderate and severe drought conditions.

In considering conditions beyond 2015, preliminary identification of supply deployment strategies, demand reduction measures and related considerations will likely highlight actions which could be taken in the near term to better prepare for these conditions (Figure 5-5). Actions may include policy establishment and long-range capital budgeting. Reassessment and refinement of these strategies will occur with each plan update.

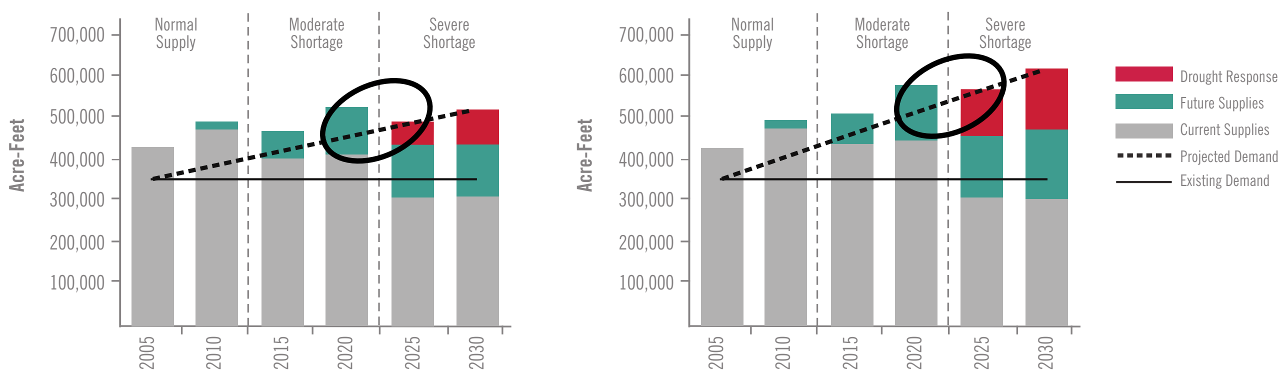


Figure 5-5. Planning for Severe Shortages by 2025

Concept 4 | Consider cost, reliability, accessibility, maintenance needs in selecting the appropriate mix of future supplies for deployment.

The costs and relative benefits of each supply option (including related infrastructure) must be considered not only in the context of drought-based shortage planning, but also to meet needs for operational flexibility and system emergencies. Spatial considerations, highlighted by the preliminary findings of the Drought Simulation Model, must also be factored in. This assessment may conclude that a variety of sources (e.g. groundwater, reclaimed water, CAP) will need to be deployed simultaneously. Diversification in the deployment of future supplies will reduce risks, and could bring cost efficiencies.

Figure 5-6 illustrates a hypothetical "stacking" of future supplies to meet growth demands under intensifying drought conditions. The shortfall (represented as "drought response") could partially be met through the recovery of prior year "excess" water (which had been stored underground). Sources available in excess of demands in certain years could be stored underground for future recovery or exchange.

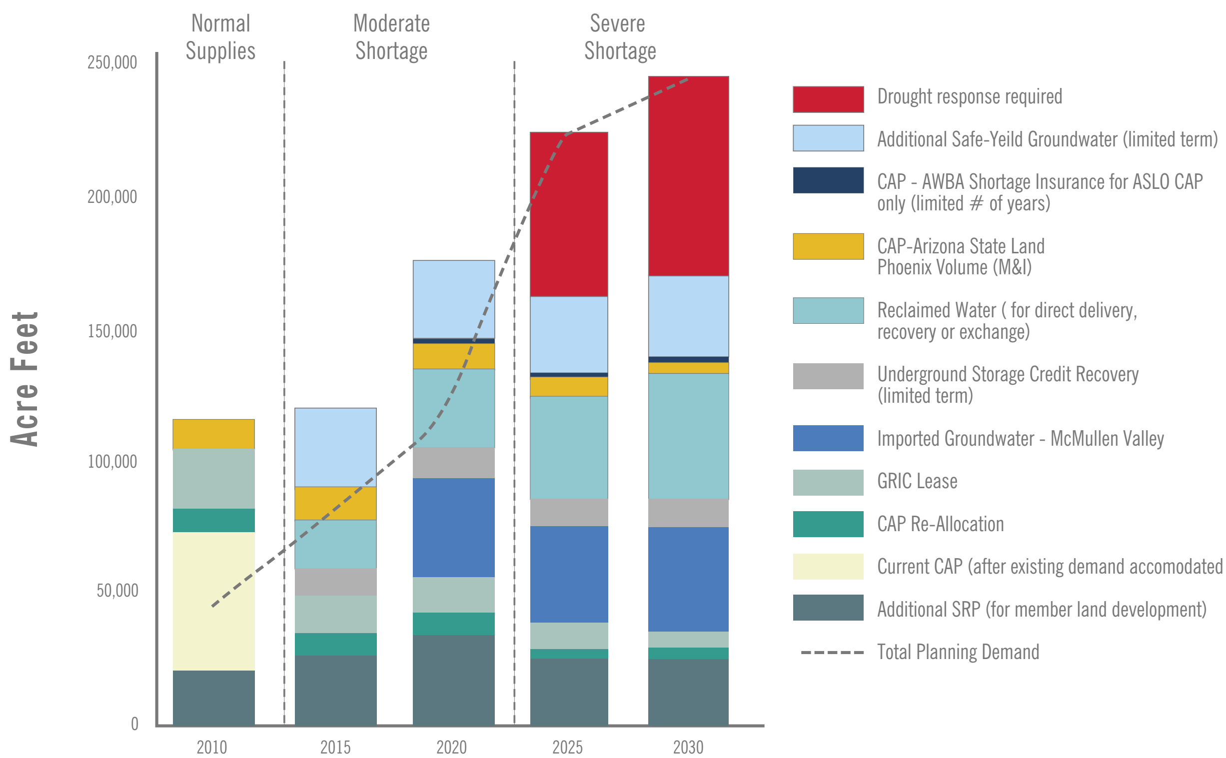


Figure 5-6. Hypothetical "stacking" of supply options.

Concept 5 | Funding for the deployment of future and supplemental supplies should be derived from growth-related revenues.

The scenarios presented in Chapter 4 conclude that if demand remained stable at today's level, current supplies would be sufficient under foreseeable conditions. This is the case even under severe shortages assuming a relatively modest reduction in customer water demand. The needs for future supply capacity are thus dictated by new development. The City's Water Resource Acquisition fee, a per-meter fee paid at the time a service connection is established for a new lot, is perhaps the most appropriate instrument for generating necessary revenues.

Though at present a combination of rate revenue and Water Resource Acquisition Fee revenue is used to fund infrastructure extensions for new development, it is anticipated that the majority of future development-related costs will be funded by development. Costs to improve the efficiency and reliability of the current system (to benefit existing customers) will continue to be covered through water rates.

Concept 6 | Promote enhanced conservation to minimize drought impacts to customers.

The conservation alternatives presented in Chapter 4 demonstrate the impact of continued gains in water use efficiency. The intention of an enhanced and expanded conservation program is to encourage new levels of efficiency which will appeal to customers for a variety of reasons, and thus become part of their behavioral pattern or "lifestyle." History has demonstrated that early introduction of structural efficiency measures (such as those associated with new homes) tend to bring the greatest benefits. These efficiencies could ultimately reduce the impact of shortages and/or represent avoided water supply deployment costs (for infrastructure and supply acquisition) (Figure 5-7).

A key element of the enhanced conservation program is the strategic reduction in the volume of lost and unaccounted for water through: 1) improved metering; 2) leak detection and repair; and 3) pressure management.

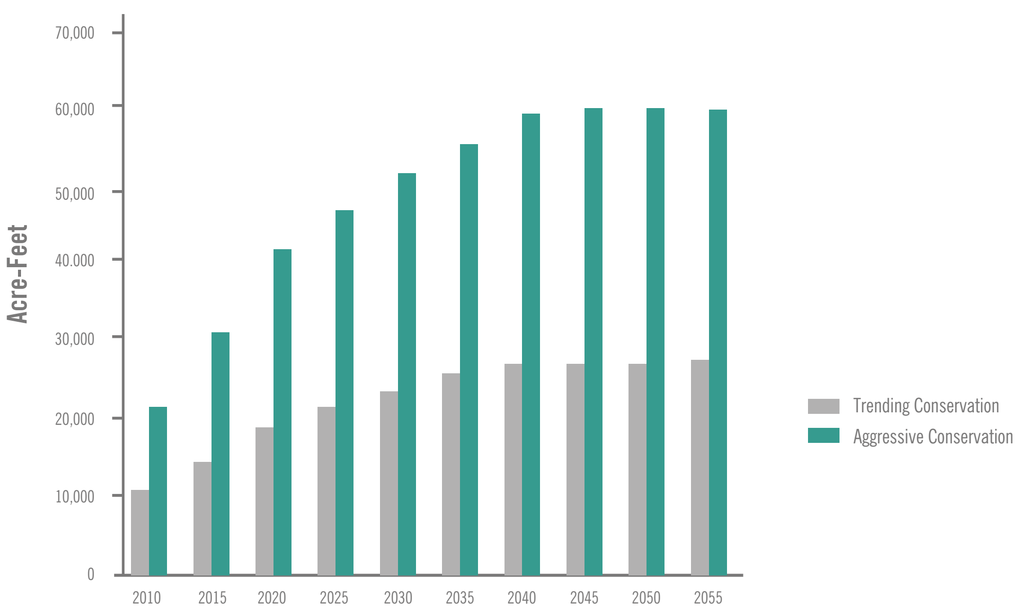


Figure 5-7. Estimated Conservation Savings (assuming General Plan growth projections)

Concept 7 | Manage groundwater supplies for aquifer sustainability

The disconnection and/or abandonment of wells due to water quality concerns and aging equipment has left Phoenix with the capability of meeting only 10 to 15 percent of its peak day demand with groundwater. This reduction in well capacity coincided with State policy direction in 1980 to reduce groundwater use, and the City subsequently invested heavily in CAP to meet this mandate. Though the City has added five production wells since 1998, a need to substantially rebuild its well capacity for drought redundancy, operating flexibility and system emergencies has been identified. In fact, from a timing perspective, it is expected that groundwater needs for operating flexibility (including peaking) and system emergencies are more compelling in the short term than needs to offset drought impacts. A comprehensive "needs assessment" will best determine how groundwater can be used most effectively in the service area. Consideration of recharge and recovery strategies will be a key element, as will the evaluation of cumulative pumping (by Phoenix and surrounding entities), especially during extended surface water shortages. A critical objective is to manage aquifers to ensure the availability of good quality groundwater when needed, and to address the risks of land subsidence and other adverse environmental impacts. To help ensure the availability of good quality groundwater, Phoenix will work closely with ADEQ and EPA on cleanup strategies for the Central Phoenix contamination issues.

Concept 8 | Maximize utilization of Reclaimed Water

Reclaimed water is a key component of the "future supplies" illustrated in the Chapter 4 model scenarios. Much of Phoenix's reclaimed water is currently committed to industrial and agricultural uses outside of the service area. However, the uncommitted portion (that which is included in the scenarios) represents a substantial future supply for the service area. Full and effective utilization of this supply begins with an updated evaluation of the means by which reclaimed water can be used (either directly or indirectly) to meet future demands. From this analysis, a phased reclaimed water master plan and funding strategy will be developed. Recharge/recovery, exchanges and other creative means to effectively use this supply may ultimately provide benefits both in terms of growth accommodation and reducing the impact of water supply shortfalls.

Concept 9 | Enhance water quality and match with appropriate uses.

A key objective is to meet or exceed all mandatory state and federal drinking water standards. Many of the sources envisioned as "future supplies" may need significantly more treatment than currently available supplies. From a groundwater perspective, the City's best quality wells are in the north part of the service area, but much of the City's demand is concentrated in the central section of the City. A large portion of the Central Phoenix aquifer is contaminated due to the past discharge of chemical compounds from industrial and agricultural practices. This should be addressed through continued City efforts to ensure that EPA and ADEQ develop contaminant plume remediation strategies which allow the Central Phoenix aquifer to be available for future potable use.

The removal of salts from both groundwater and surface water supplies to improve overall quality and reduce potential damages or usage limitations should be aggressively pursued as technology costs decrease. High efficiency desalination processes (which reduce the volume of water lost via concentrate) should be considered. Concentrate management stands as one of the most costly aspects of desalination processes. The City should continue to work with regional and national interests in supporting advanced technology research and should facilitate the piloting and full scale implementation of these processes for the benefit of Phoenix customers.

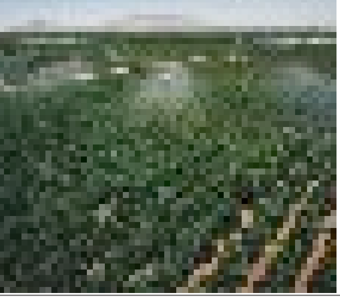
The City should also consider identifying uses within the service area which could receive alternative local supplies in place of water from the potable system. For example, it may be practical to further expand utilization of non-potable surface water supplies and reclaimed water supplies for turf facility irrigation, or to utilize non-potable groundwater for such purposes.

Concept 10 | Consider environmental benefits and costs in the analysis of water supply and demand management efforts.

The City on its own, and in partnership with other area water users, state representatives and the federal government have been engaged in a multitude of efforts directed at habitat protection and restoration within source watersheds. To date, negotiations have led to successful outcomes which effectively balance social, economic, and environmental concerns in the planning, acquisition, treatment, and distribution of water resources. In deployment of future and supplemental sources and in continuing negotiations regarding existing supplies, the City should continue to strive for this balance.

Strategic location and operation of wells may also bring benefits with regard to plume containment and cleanup efforts. As potential well sites are evaluated, ongoing or planned plume remediation efforts would be considered to determine if the locations would support such efforts without compromising the quality of the water supply.



Concept 11 | Pursue opportunities for supplemental water supplies and demand reduction measures that could be deployed during extreme drought.

The scenarios and planning timelines depict conditions under which "drought response" (deployment of supplemental supplies or demand reduction measures) becomes necessary. The Water Services Department's first priority is to meet demands to the highest degree practical. When facing drought-related shortages, this could be accomplished through acquisition of "dry-year fallowing options," (agreements for high-priority agricultural water), enhanced underground storage and recovery, exchanges or further expansion of groundwater capacity. When cost or logistical impediments preclude supplemental supply deployment, the City must be prepared to effect customer demand reduction. Both supplemental supply acquisition and demand reduction measures will be addressed in an updated drought response plan.

Concept 12 | Promote regional cooperation in deployment of drought supplies and strategies.

Each municipal water system, private water company, water district and water wholesaler in the region has distinctive water supply and demand characteristics and encounters unique challenges in meeting growing customer demands and preparing for drought. However, a regional strategic analysis could identify substantial opportunities for collaborative efforts among entities which could strengthen each entity. For example, with regard to supply deployment, it may be more efficient to identify and utilize surplus well capacity in certain systems which can be used by others (directly or indirectly) via exchange or other compensation. Securing dry-year farm fallowing agreements (with farmers holding higher-priority water rights) would also be more effectively accomplished through a collaborative effort. With respect to conservation and drought-based reductions, a common set of guidelines for directing and advising all Valley water customers (which respects each entity's unique circumstances) would reduce confusion resulting from multiple jurisdictions and programs, while leveraging the common media opportunities in the region. As the largest water utility in the state, Phoenix is in a unique role to lead or substantively participate in such efforts.
These strategic concepts serve as a foundation for more the specific objectives and alternative approaches described in the next chapter.

CHAPTER VI
STRATEGIC DIRECTIONS

CHAPTER 6

STRATEGIC DIRECTIONS

Mexican Gold Poppy

The analysis in the prior chapters demonstrates that for most foreseeable scenarios, Phoenix has sufficient water supplies (current and future) to meet expected demands. These supplies can be stretched even further with an expanded emphasis on conservation and other demand management tools. However, deployment of future supplies to meet growth and redundancy needs will require further infrastructure enhancements.

The primary emphasis of Phoenix's water resource planning efforts in the coming years will be on the following:

- Protecting, maintaining and effectively managing Phoenix's current supplies;
- Expanding infrastructure to accommodate deployment of future supplies for growth and redundancy needs; and
- Developing cooperative arrangements with other suppliers and wholesalers in the region to address common objectives through more cost-effective means.

The specific steps necessary to guide actions will be detailed in functional plans which will be developed as an extension of this Water Resources Plan Update. The recommended functional plans along with potential approaches and considerations are presented in this chapter.

FUNCTIONAL PLANS

Seven functional plans have been identified, and the need for others may arise in the future. The plans to be developed over the next two years include the following:

- Groundwater and Reclaimed Water Management Plan
- Water and Wastewater System Master Plans
- Demand Management Plan
- Assured Water Supply Plan
- Salinity Control and Desalination Plan
- Water Resource Acquisition Fee Update
- Capital Improvement Plan – Water Resource Component

Groundwater and Reclaimed Water Management Plan | This plan (for the entire service area and by demand zone) will identify the volume of groundwater (including recovered recharge credits) and the number of wells needed to: 1) meet demands under moderate drought conditions; 2) provide necessary operating system flexibility (to meet peak demands), and 3) maintain a reasonable volume of water to customers during system emergencies. The Plan will also incorporate needs for recharge within the service area, and will assess and prescribe means for best managing available reclaimed water supplies.

Water System Master Plan | The City is conducting an update of the Water System Master Plan and the Wastewater System Master Plan concurrent with this Water Resources Plan Update. These detailed infrastructure plans will specify system features and sizing necessary to meet expected growth. These system master plans are critical in establishing capital improvement schedules and funding requirements, and in negotiating development agreements. These plans are expected to be completed in early 2006.

Demand Management Plan | The City's Water Conservation Plan, last updated in 1998, will be revised to reflect technological advances and other opportunities for achieving deeper levels of conservation. As indicated in earlier chapters, conservation plays a key role in reducing or avoiding costs associated with new supply acquisition and deployment. The City also anticipates revising the Drought Management Plan to reflect "lessons learned" from the recent surface water shortages and related public and media involvement. Though each of the two plans requires a unique approach, the two will be developed concurrently to better distinguish between long-term conservation "lifestyle" measures and shorter term measures which are dictated by surface water shortages or emergencies.

Assured Water Supply Plan | Phoenix's Designation of Assured Water Supply ("designation"), confirmed by ADWR, allows new subdivisions to be added to the water system. The designation avoids substantial filings and delays associated with the alternative approach (filing for individual Certificates of Assured Water Supply), and serves as the State of Arizona's endorsement that the City has taken proactive steps to acquire sufficient renewable supplies to accommodate anticipated growth.

Pursuant to the AWS Rules, Phoenix's existing Designation will need to be reviewed by ADWR no later than 2010. The projected demands for the year 2010 are the basis for the current designation.[22] Therefore, the City is planning to submit an application well in advance to maintain a continuous designation status. This updated Water Resources Plan is a foundation for demonstrating consistency with the AWS Rules in qualifying for an extension of the current designation.

Reverse Osmosis Groundwater Desalination Facility

[22] ADWR's policy regarding initial designations of assured water supply (which were issued in 1997-98) considered 2010 demand as the latest target year. As providers will be renewing designations in the coming years, it is expected that ADWR will revise the maximum target year to 2020 or 2025.

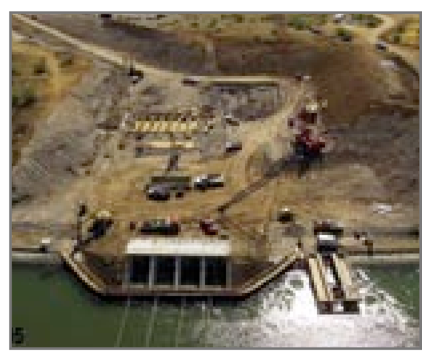
Salinity Control and Desalination Plan | As the City increases utilization of groundwater, reclaimed water and imported surface water, relatively high salinity levels in these sources will need to be addressed. Phoenix, other SROG cities, the USBR and other stakeholders have been conducting the CASS over the past four years in an attempt to identify potential remedies. Recommendations from this study, expected to be complete in early 2006, will generally address the cost effectiveness of various measures. More than two-thirds of the salinity originates in source watersheds. Therefore, continued support of the CRBSCF's efforts to reduce salt inflows is important. These recommendations, and other associated measures and strategies will be considered by the City in developing a Salinity Control and Desalination Plan directed specifically toward Phoenix water and wastewater systems.

Water Resource Acquisition Fee Update | Deployment costs relative to future water supply acquisition and infrastructure development will far exceed past expenditures for supplies and features. Most water supply projects and supply acquisitions are paid for with Capital Improvement Program bond funds. To help provide funds for repayment of bond debt, Phoenix implemented a Water Resource Acquisition Fee in 1990. The fee is charged at the time building permits are issued for all new residential and commercial buildings. The fee is based on the estimated costs of a representative mix of projects listed in the City's Water Resources Plans. The Water Resource Acquisition fee helps minimize impacts of new supplies on the water rates charged to residents and businesses in Phoenix.

Estimated costs of the approaches presented in this chapter are being developed through a concurrent effort addressing the Water Resource Acquisition Fee Update. It is expected that adjustments to this fee will be proposed in 2006. Because the exact courses of action associated with these approaches have yet to be determined, the updated Water Resource Acquisition Fee is expected to reflect the average cost to meet water supply and infrastructure needs for both growth and moderate drought through 2025.

Capital Improvement Plan—Water Resource Component | The scheduling of major water acquisition and infrastructure projects can be better incorporated into the City's annual Capital Improvement Plans through maintenance of a separate water resource plan component. This component would establish long-term scheduling and funding requirements for water resource projects and ensure consistency with revenues from Water Resource Acquisition Fees and other relevant sources.

The following sections describe specific elements and strategies which may be considered in developing the functional plans and in other water resource program development efforts.



SUPPLY MANAGEMENT CONSIDERATIONS

Assured Water Supply | Since an overriding goal of Phoenix's Water Resource Planning efforts is to ensure availability of sustainable water supplies for current and new development through 2055 under normal and shortage conditions, the standard used in the Phoenix planning process is more rigorous than the State's AWS standard. As such, the City does not anticipate any obstacles in extending its AWS Designation.

Recharge and Recovery | In the early part of the 50-year planning period, and in normal supply years throughout the period, Phoenix has access to renewable supplies which exceed demands. This provides an opportunity to strengthen the City's future portfolio through the underground storage of these excess renewable supplies when available. The State's recharge statutes provide for the accrual of credits for water stored underground, which can later be pumped or recovered. Credits are granted to the storing entity for the volume recharged, less a "cut to the aquifer" which varies depending on the type of facility and/or water stored. The major recharge facilities utilized by Phoenix include the following:

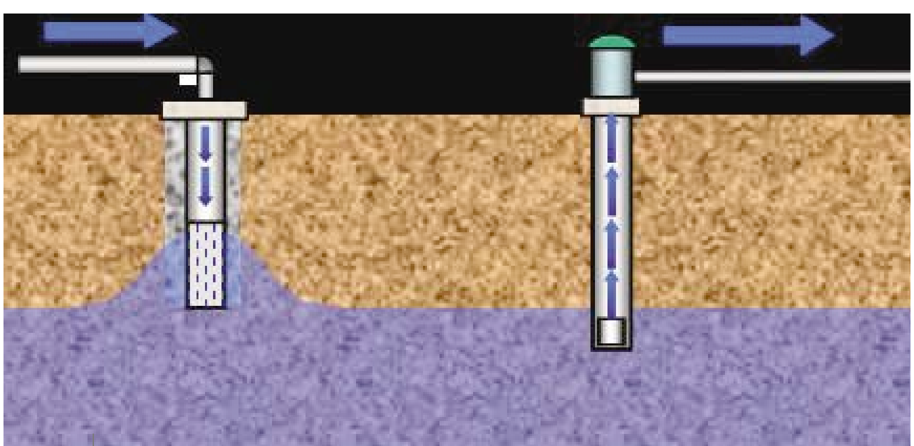
Granite Reef Underground Storage Project – A basin recharge facility in which CAP water and other surface water supplies may be stored.

SRP's Groundwater Savings Facility – an "in-lieu" recharge facility comprising the SRP service area. Groundwater is left underground by SRP in exchange for Phoenix delivering its excess CAP water (and other available sources) to SRP to meet demands which would have otherwise been met with groundwater. Phoenix obtains credits for the water provided to SRP.

Roosevelt Irrigation District's Groundwater Savings Facility – an "in-lieu" facility which accepts reclaimed water from Phoenix's 23rd Avenue plant for delivery to farmers in RID. Groundwater not pumped by RID is credited to the City of Phoenix.

North Phoenix System Recharge – Phoenix stores small quantities of CAP water obtained from the distribution system at several sites in North Phoenix primarily to support system water quality standards.

In addition, the City recently received permits to store reclaimed water through vadose zone injection at the CCWRP in North Phoenix. This facility, once paired with recovery wells, will assist in equalizing the current imbalance between the timing of demand and the timing of supply availability. It will also allow for discontinuous expansion of the reclaimed water system in North Phoenix, thus saving transmission system construction costs.



Aquifer Recharge and Recovery via Vadose Zone Wells

Other opportunities considered for recharge include:

The Agua Fria Linear Recharge Project | a proposed "Managed Facility" along the Agua Fria River (Figure 6-1). Reclaimed water from the 91st Avenue WWTP would be piped north to Bell Road, and discharged into the river at several locations between Bell and Indian School roads. The proposed project is a collaborative effort involving SROG and several other stakeholders, in conjunction with the USBR water stored by Phoenix would likely be recovered from wells in the Phoenix service area. The current capital cost estimate for this project ranges from $200 to $250 million. Funding sources have not yet been identified, though federal matching funds may be available to partially offset local expenses. The project team is currently evaluating groundwater conditions, environmental impacts and permitting aspects of the proposed project. If the study results are positive and sufficient funding is identified, the project could be in operation in the 2009-2010 timeframe.

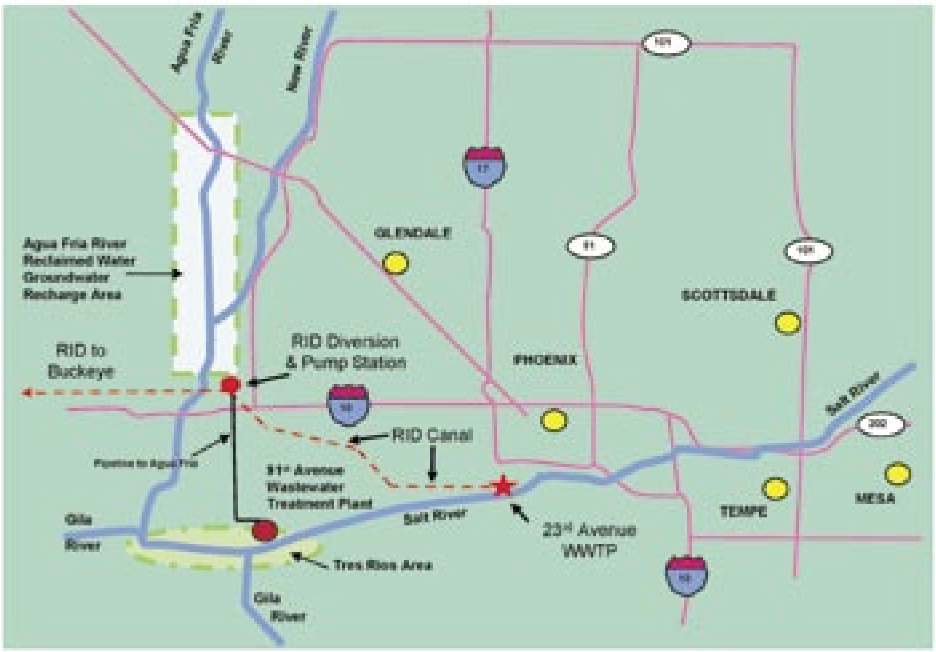


Figure 6-1. Agua Fria Linear Recharge Project

Reach 11 Storage | The City recently completed a joint study of aquifer conditions in the northeast Phoenix/North Scottsdale area with the City of Scottsdale. The findings of the Northeast Valley Aquifer Management Study demonstrate a need for further CAP and/or reclaimed water recharge in the vicinity, preferably in the Reach 11 area to maintain the sustainability of the aquifer for future use. Recharge in this area could help stabilize groundwater level conditions (which are affected by pumping by Phoenix, Scottsdale, Paradise Valley, SRP and others within or south of the study area). Further study is needed to assess Phoenix's options for drought protection in this part of its service area, whether recharge can reduce or eliminate the conditions leading to subsidence, and if a cooperative program in the vicinity with entities such as SRP, CAP or the AWBA could reap the desired aquifer sustainability.

The City may seek to identify other appropriate sites to store water within the service area, especially where aquifer supplementation is necessary to meet well capacity needs at specific locations, or under certain shortage conditions (Figure 6-2). Phoenix could also store water outside of its service area at any number of existing "constructed" or "in-lieu" facilities.

Figure 6-2. Recharge and Recovery Projects

Other Management Activities

Additional continuing and future water management efforts include (but are not limited to) the following:

- Managing recharge options, with a priority on storage within the service area;
- Leveraging reclaimed water availability through exchanges;
- Complying with State water management mandates;
- Effectively utilizing regulatory provisions and incentives to maximize supply benefits;
- Participating in continued dialog with federal, state, regional interests and environmental advocates with regard to endangered species issues which may impact water supply availability;
- Ensuring aquifer remediation (cleanup) efforts are expediently undertaken to prepare groundwater reserves for use by Phoenix customers;
- Evaluating water use records and identifying trends to sharpen the planning focus;
- Managing water supply orders to preserve Phoenix's entitlements to reservoir supplies (Roosevelt NCS water, Gatewater) when sufficient CAP is available;
- Monitoring activities in source watersheds which could impact water supply availability;
- Promoting additional conservation among customers and within City operations;
- Continuing to maintain distribution system losses below the 10 percent regulatory standard, and seeking further loss reductions;
- Collaborating with other municipalities and suppliers to efficiently and effectively manage local groundwater and surface water supplies;
- Participating in efforts to refine regulatory processes (ADWR, ADEQ, EPA, USFWS and other entities);
- Protecting the City's water rights;
- Promoting recovery planning for CAP supplies stored by the AWBA;
- Participating in the process for determining shortage criteria and reservoir management options on the Colorado River.

CAP/SRP Interconnect Facility

Groundwater Well

SYSTEM AND SUPPLY REDUNDANCY

This Water Resources Plan Update primarily addresses water resource needs for growth and surface water shortfalls through a service area-wide approach. When evaluated from this level, significant redundancy is already built into the system via excess treatment plant capacity, the ability to move water through the SRP/CAP interconnect, and well capacity.

Treatment Plant Capacity | Phoenix's current peak-day demand is approximately 430 million gallons, and the surface water treatment plants are presently capable of providing 630 mgd. By 2015, surface water treatment plants will expand to a capability of between 700 and 790 mgd. Because the locations served by these plants overlap, there is already substantial redundancy built in to the system. This allows for routine shutdowns for plant or canal maintenance without compromising the distribution system. However, no single plant can service the entire distribution system.

SRP/CAP Interconnect Facility | Supplies from the CAP canal can be transferred to the SRP canal system through an interconnect facility. Phoenix owns 145 mgd of capacity in this facility. This provides a degree of supply redundancy for areas served by the plants on the SRP canal system. This redundancy may be most beneficial when SRP supplies are curtailed and supplies transported through the CAP canal are abundant.

Existing Well Capacity | Existing well capacity (approximately 60 mgd) also meets a portion of the redundancy needs in the northern portions of the service area, which are more CAP canal-dependent.

Redundancy Enhancements | Increased redundancy to address surface water shortfalls could be accommodated through well capacity enhancements, canal supplementation, and/or exchanges. However, the needs for redundancy to address potential surface water shortages in the next 10 to 15 years may not be as pressing as redundancy needed for operating system flexibility (primarily peaking needs) and potential system emergencies. The options presented in the next section primarily address redundancy relating to shortage conditions. Phoenix's Water System Master Plan Update (which is being developed concurrent with this plan) and other related efforts are addressing detailed system needs. Ultimate solutions will be determined after considering the needs for all three objectives collectively.

POTENTIAL SUPPLY DEPLOYMENT APPROACHES

In developing a program to meet needs for redundancy and growth in demand, a number of potential approaches may be considered. These include the following, many of which are interrelated:

- Increasing groundwater production capacity, and supplementing aquifer storage through recharge where necessary;
- Importation of groundwater from the City's McMullen Valley water farm;
- Increasing reclaimed water utilization through expansion of reclaimed water distribution systems (to displace demand from the potable system) and through recharge and recovery;
- Acquisition of additional Colorado River supplies or land fallowing options (to increase "buffer");
- Infrastructure partnerships with one or more other suppliers/wholesalers; and
- Demand management (traditional conservation and event-based demand reductions).
- This plan prompts near-term decisions on certain strategies to prepare for the next 10 to 20 years, while preparing for additional strategies covering a longer period. These potential approaches discussed below are within this context.

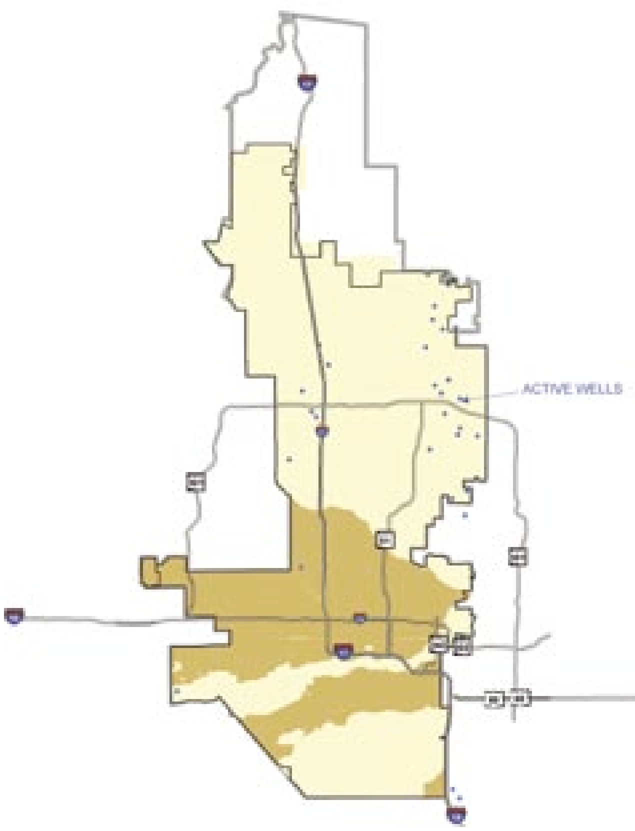


Figure 6-3. City of Phoenix Active Well Locations

APPROACH 1 | INCREASE GROUNDWATER PRODUCTION CAPACITY

Phoenix typically maintains over 60 mgd of active well capacity, primarily in the northern portions of the City (Figure 6-3).Though the City typically uses groundwater for less than 3 percent of its total demands, wells are an essential element in providing water supply and infrastructure redundancy. This redundancy is necessary to: 1) mitigate surface water shortages due to drought; 2) provide operation system flexibility during periods of maintenance; and 3) to maintain customer deliveries in the event of water treatment plant or transmission system breakdowns. As additional well capacity is added over the next five to ten years, attempts will be made to consider these conditions and relative spatial needs in identifying optimal sites.

Legal Availability of Groundwater | The Groundwater Code significantly restricts the use of groundwater with the intent of preserving the source for use during surface water shortages. The Code and associated AWS rules grant groundwater allowances which may be used at a provider's discretion throughout the 100-year term of the Designation of AWS. The City currently maintains a bank of more than 2 million AF of groundwater credits (20,000 AF per year for 100 years). In addition, a volume reflecting 4.3 percent of demand is added to this account annually to account for "incidental recharge" or water infiltrating back to the aquifer due to usage by Phoenix customers. This groundwater is sometimes referred to as "safe-yield" groundwater as it is deemed by regulations as consistent with the statutory objective of safe yield by 2025. In a normal year, the City will use between 4,000 and 10,000 AF of groundwater (mainly for short term system maintenance needs).

Recharge statutes also provide an opportunity to increase the amount of water which can be pumped from wells. By storing water underground through any number of techniques (basin infiltration, direct injection, discharge to natural watercourses or "in-lieu" substitutions), the storing entity receives credits to pump that water in future years. The water may be pumped from the area of recharge or anywhere in the Active Management Area. This provides substantial flexibility in allowing Phoenix to store water either within or outside of the service area, and pump ("recover") the water from existing or future service area wells. When recovered, the water retains the legal nature of the water stored (i.e., it is not charged to the groundwater allowance account).

In cases where new service area wells or recovery wells are needed, the State's well spacing rules apply. These rules protect current well owners from unreasonable impacts due to pumping from new large capacity wells. The limitations imposed under these rules could prevent the City from constructing wells in certain locations within the service area.

Physical Availability of Groundwater | Aquifer conditions vary throughout the City, but in general the most abundant supplies are in the central portion of the service area. Within this area, the aquifer is deepest, transmissivity values are high and water levels are comparatively shallow (between 50 and 300 feet below land surface compared to between 450 to 900 feet in the northern reaches). In some portions of the service area, especially in the far north and near mountain preserves, aquifer production capabilities are somewhat limited due to geologic conditions.

Groundwater Quality and Treatment | The best quality groundwater is found in the northern part of t he service area, where most active wells are located. However, limitations in aquifer production in the northern area will redirect well capacity expansion activities to the central "on-project" areas where groundwater reserves are much more plentiful. As referenced in Chapter 2, high TDS, arsenic and nitrates, and the presence of volatile organic compounds (VOCs) currently limit the use of groundwater in this area. The poor quality of these central area aquifer supplies dictates cleanup of contamination, or in a worse case, costly wellhead treatment. With regard to VOC contamination, Phoenix continues to urge EPA and ADEQ to accelerate remediation efforts to ensure that this source is available to Phoenix customers during drought or other emergencies.

Preliminary Estimate of Groundwater Capacity Required | Estimates of groundwater capacity needs and the timing of these needs have varied substantially in past plans and related studies. These variations underscore the benefits of periodic evaluation, and the consideration of current trends and uncertainties. This planning effort attempts to identify, at a cursory level, capacity enhancements covering the next 10 years to prepare for assumed continuing dry conditions in source watersheds. Ensuing studies and plans will further refine these needs and extend the planning horizon. The actual volume of well capacity needed will be based on a more detailed evaluation of water system constraints, which is occurring through the City's Water System Master Plan update and a planned 2006 effort to develop an overall groundwater management plan for the City (discussed in Chapter 6).

Preliminary analyses of potential shortfalls due to moderate drought conditions in 2015 conclude that between 20,000 and 28,000 AF of additional groundwater may be needed to mitigate these shortfalls. This could equate to a need for approximately 20 wells. Though further analysis of spatial needs and system management options will be necessary, preliminary results of the Drought Simulation Model highlight the central and north-central parts of the service area as the most appropriate locations for additional well capacity. Capacity needs could increase based on a more detailed spatial evaluation, or they could be less if other non-well options are deployed.

Opportunities to Expand Well Capacity | Three primary approaches have been identified to increase well capacity, which may be used in any combination. These include:

1. Rehabilitate or drill new Phoenix wells within Phoenix distribution system

Phoenix continues to maintain access to several well sites where facilities have been disconnected due to groundwater contamination or aging equipment. These sites provide opportunities for well rehabilitation and/or re-drilling, though water quality would be a major consideration. Blending, under a program approved by ADEQ, could reduce the need for wellhead treatment (for nitrates, TDS and/or arsenic).

2. Partner with SRP to rehabilitate existing SRP wells or drill new SRP wells for connection to the Phoenix distribution system

As discussed in Chapter 2, SRP has initiated a "Groundwater Restoration Program" to rebuild well capacity lost over the years due to urbanization of on-project lands. This lost capacity impedes SRP's ability to maintain allocations during shortfalls. SRP's program seeks to drill or rehabilitate up to an estimated 100 wells over a 12 year period. SRP has requested that Phoenix consider directly connecting "stranded" wells to the Phoenix distribution system (where quality and access are suitable), or that the City pursue other partnership opportunities with SRP for well utilization. SRP's program and possible participation by the City may shore up access to "special pump rights" (City rights to groundwater well capacity developed by SRP above and beyond rights of SRP shareholders). Potential institutional limitations associated with this program will need to be examined.

3. Rehabilitate or drill new wells for discharge to SRP or CAP canals

Phoenix could potentially partner with SRP or other entities to increase supplies available to canals during surface water shortages. SRP, through its Groundwater Restoration Program, will seek to increase capacity along its main canal systems. With respect to the AWBA backup of CAP supplies, it is anticipated that the supplemental water would be produced from wells outside of the Phoenix service area. To the degree that AWBA recovery was to occur (in part) within the Phoenix service area, opportunities may exist to jointly create recovery capacity. The wells could serve both AWBA needs and Phoenix service area needs. These strategies would provide benefits of utilizing existing treatment plants and distribution systems, and reduce the need for wellhead treatment. However, the approach would have limited effectiveness in addressing operating system flexibility or emergency needs (where well water is not independent of water treatment plants).

Standby Capacity Considerations | Decisions regarding the ultimate volume of well capacity deployed will need to consider standby costs. Substantial expenses may be incurred in maintaining wells for potential surface water shortages. For example, regardless of whether they are needed at any given time, all wells connected to the system must be monitored for compliance with water quality standards on a quarterly basis (which entails operation of the wells). The effective cost of this standby capacity could be reduced if the wells are used for credit recovery or for system operational flexibility.

Site Acquisition | Though the City has several sites where new or rehabilitated wells could be operated (especially where wells have been disconnected due to age or contamination), some sites may not be located appropriately within the system, maintain the appropriate zoning or be of a sufficient size to handle wellhead treatment equipment, chemical storage, etc. The logistics and expense of acquiring additional sites in new or developed areas could impede well capacity expansion actions.

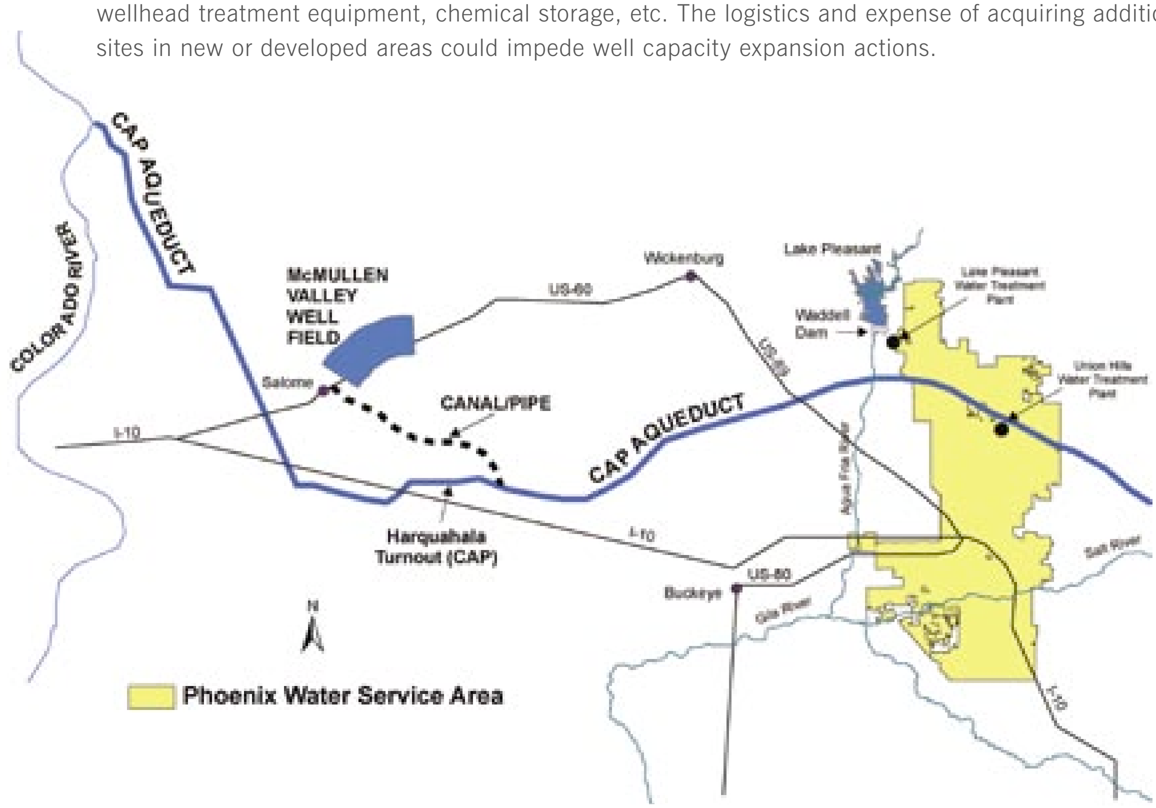


Figure 6-4. McMullen Valley Farm and potential transportation system

APPROACH 2 | IMPORT GROUNDWATER FROM THE MCMULLEN VALLEY

The City has conducted extensive studies of the water resources of the McMullen Valley to identify the quantity of good quality water that is available. The Arizona Groundwater Transfer Act of 1991 (in A.R.S. 45-552) granted Phoenix the authority to withdraw and transport this water to its service area for municipal use.

Phoenix has leased acreage to growers each year to defray operating and debt service costs on the land purchase. The City is also assessing other land use options to preserve the regional economy, minimize water use, and provide income to defray the land holding cost of about $1.9 million per year until the water is needed.

Volume and Timing | The average volume available for transfer is up to 38,000 AF per year. However, twice that amount may be pumped in any one year (as long as the 10-year average does not exceed 38,000 per year). Prior Water Resources Plans had considered the importation after the year 2030, primarily for growth-related needs. However, earlier implementation of this approach could reduce the number of new service area wells (within Phoenix) needed to address surface water shortfalls.

At present, the plan is for the McMullen Valley supply to serve only Phoenix's needs. However, the City may consider partnering with other entities (including the CAP and/or CAGRD) to more effectively utilize the supply. One alternative could involve utilization of McMullen Valley groundwater as part of an overall "insurance" package on municipal CAP supplies that would also incorporate AWBA credits and land-fallowing options.

Implementation Steps | Several steps will be necessary to affect the transfer and conveyance of groundwater from the McMullen Valley. These include:

- Determining the appropriate pipeline alignment from a series of options;
- Obtaining a wheeling agreement with the CAP to utilize the 38,000 AF per year "set aside" of excess CAP canal capacity granted to the City by the CAWCD;
- Developing the well field, pumps and conveyance system, including a 34-mile pipeline to the CAP canal;
- Ensuring compliance with NEPA, if necessary;
- Analyzing easement and right-of-way for pipeline through the Bureau of Land Management holdings, La Paz County, state lands, and private land;
- Assessing groundwater quality to determine treatment needs (if any) prior to blending with CAP Colorado River water

With regard to the wheeling agreement, the CAP Board in 2002 acknowledged Phoenix's need through an "interim set aside" of excess CAP canal capacity of 38,000 acre feet per year. The use of excess canal capacity will be limited to times of the year when capacity exists. However, if the supply were to be transported during periods of Colorado River shortages, it is assumed that normal (rather than excess) canal capacity could be utilized (though a wheeling agreement would still be necessary).

1992 Study | In 1992, an extensive study of the McMullen Valley project was conducted. The study assessed groundwater quality and quantity, legal and institutional constraints, CAP canal considerations, well field alternatives, groundwater modeling and pipeline conveyance alternatives. The study concluded that sufficient good quality groundwater exists to meet the maximum entitlement (six million AF) and that the project life was more than 150 years (based on continuous pumping at the average volume). The study suggested upsizing the system to allow for conveyance of up to 50,000 AF per year. A major advantage of this supply, like local groundwater, is its stability during drought. This supply could also make use of the City's existing treatment and distribution system infrastructure.

23rd Avenue WWTP

91st Avenue WWTP

APPROACH 3 | INCREASE RECLAIMED WATER UTILIZATION

Reclaimed water available to Phoenix will increase over time due to increased service area demand. An additional factor to consider involves the diminishment of the "three way" exchange and the RID GSF over time due to urbanization of agricultural lands. These factors illustrate the need to identify, well in advance, means of effectively utilizing this supply. Significant advantages of this supply include reliability during drought and the lack of acquisition costs (the supply is already "owned"). However, treatment, transmission and/or recharge expenses could be significant.

Volume | The anticipated volume available for potential utilization or recharge ranges from 40,000 AF per year to 160,000 AF per year. The actual amount available may fluctuate significantly from year to year due to varying conditions which include:

- Full utilization of the contract volume by the Arizona Nuclear Power Plant (ANPP) which could increase usage by between 30,000 and 40,000 AF to a total of more than 100,000 AF per year
- Completion of the full scale Tres Rios project (which may require up to 28,000 AF per year)
- Construction of the Rio Salado Oeste Habitat Restoration Project (approximately 8,000 AF per year)
- Diminishment of agricultural land associated with the "three-way exchange"
- Demand fluctuations involving the BIC
- Development of North Phoenix

Some of these commitments involve contractual obligations, and thus available reclaimed water could be used on a "spot" basis when not taken by the contractor. This is largely the rationale behind the proposed Agua Fria Linear Recharge Project which will recharge the unused apportionments during the low-demand periods. The credits then become the basis for a firm supply.

Options for Utilizing Reclaimed Water | Several options for utilizing reclaimed water have been identified. These include:

1. Expand North Phoenix Reclaimed Water Distribution System

A study completed in 2004 identified opportunities and obstacles involved with expanding this system. Generally, demand for the source in this area is not developing as rapidly as anticipated in prior plans. Also, the costs of expanding the system to the few potential new customers present a substantial financial commitment for the City and/or developers. Expansion to cover existing large uses which could be supplanted with reclaimed water was also considered, but not found to be cost effective at this time.

Potential options for increasing reclaimed water utilization in North Phoenix include: 1) recharge and recovery, whereby stored water could be recovered on a dispersed basis, thus saving pipeline extension costs; and 2) establishment of small "skimming" plants or major wastewater lines to generate relatively small localized volumes for irrigation of golf courses and parks.

2. Store 91st and 23rd Avenue Reclaimed Water at the Agua Fria Linear Recharge Project

This project was discussed previously. Major obstacles involve capital costs and the need for remote recovery (lack of direct impact on the area from which water will be pumped). The project would, however, serve as an effective means of equalizing seasonal imbalances between supply and demand. The project could also serve as a means of storing excess 23rd Avenue reclaimed water as agricultural demand in the RID diminishes. Well capacity in the service area must, however, be developed in sufficient quantities to meet recovery needs.

Potential funding opportunities could involve partnerships with current and potential users of the reclaimed water.

3. Construct non-potable distributions to large Phoenix users from 91st Avenue, 23rd Avenue and Cave Creek plants

Substantial potential exists within the Phoenix service area to offset demands currently served by the potable system with reclaimed water. However related construction and right-of-way costs for what could be an expansive system may render this option impractical in many instances.

Tatum Ranch Fairway

Pre-reclamation

4. Purify and Blend with Surface Water Supplies

Though the technology exists to purify reclaimed water to comply with drinking water quality standards, state regulations do not yet allow for the direct “pipe to pipe” introduction of purified reclaimed water into potable systems. However, in the future, the purified water could be stored underground for recovery, or perhaps blended with surface water supplies for further treatment at traditional surface water treatment plants. The San Diego County Water Authority is presently embarking on such a blending program to enhance water availability in that region. After substantial initial resistance by some stakeholders (who coined the emotion-stirring “toilet to tap” slogan), most parties in San Diego are now comfortable with the safety assurances of the treatment plan. It should be noted that most large surface water systems contain treated reclaimed water that has been discharged by upstream entities. This is the case with both of Phoenix’s source watersheds.

If such a program were to be successful in the Phoenix area, substantial opportunities would be opened up for use of existing potable distribution systems to convey the blended purified reclaimed water. This could be substantially less costly than construction of a separate non-potable distribution system, and would allow use of existing surface water reservoirs to address seasonal variations in demand. This approach may be viewed as a part of a long-term initiative to fully utilize reclaimed water.

5. Exchange with West Valley Entities

Substantial growth is anticipated west of Phoenix, with the Town of Buckeye itself expected to grow to a population of 250,000 by 2025. Recent efforts by WESTCAPS have concluded that projected demands of most West Valley communities are likely to exceed available renewable water resources, and that reclaimed water is an important part of the solution. In some cases, entities have acquired CAP allocations, but lack direct access to these allocations. An opportunity may exist to develop agreements with West Valley entities for the distribution of 91st Avenue WWTP reclaimed water to meet non-potable demands. Phoenix (in conjunction with the other SROG partners) could, under the exchange scenario, receive an equal volume of CAP water at their existing treatment plants. Complex negotiations and funding agreements would likely be involved.

These and other potential options for utilization of reclaimed water should be considered as part of an updated Reclaimed Water Utilization Master Plan effort. (briefly described in Chapter 6).

APPROACH 4 | ACQUIRE ADDITIONAL COLORADO RIVER SUPPLIES

For the most part, the Colorado River has been fully allocated. However, water rights settlements and prior agreements dictate the re-allocation of specific CAP allocations. In addition, opportunities may exist to purchase main stem Colorado River water and transfer the supply to Central Arizona via the CAP canal (though significant issues such as cost, NEPA compliance, transportation and water right transfers/agreements would require significant lead time to resolve).

Arizona State Land Department—Commitment to Phoenix | The Arizona State Land Department (ASLD) contracted for 39,000 AF per year of M&I priority CAP water. Of that amount, 12,000 AF per year was anticipated to be provided by ASLD to City of Phoenix service area lands north of Jomax Road. The original CAP water allocation did not directly grant a supply to Phoenix for lands north of Jomax Road. A 1986 letter from the State Land Commissioner acknowledges the commitment of 12,000 AF to Phoenix. This and prior water resource plans assume that the 12,000 AF allocation will be transferred to the City.

Upon possession, Phoenix would reimburse ASLD for the prior capital charges (with interest) incurred by ASLD (approximately $8 million at present). Despite substantial discussions and draft agreements over nearly 20 years, the City and ASLD to date have been unable to successfully negotiate an agreement for the phased transfer, despite the imminent development of substantial State land north of Jomax Road. The City will continue dialog with ASLD to attain a mutually acceptable agreement for the transfer of this committed supply.

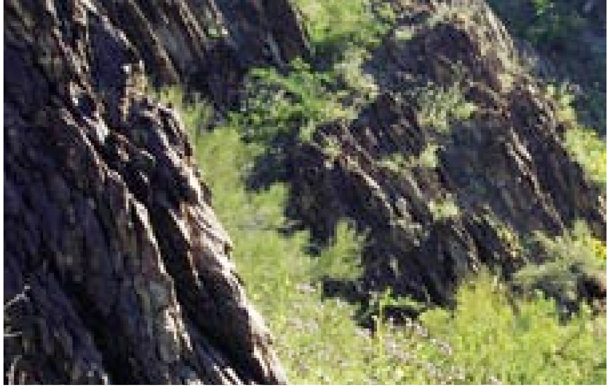
Additional CAP Agricultural-Priority Water | As part of the Arizona Water Settlements Act of 2004, an expected volume between 75,000 and 92,000 AF of agricultural priority CAP water will be re-allocated (through ADWR) to municipal users. The 2000 Water Resources Plan stated that "...a reasonable expectation for a fair share for Phoenix is 20,000 AF per year." The expectation at that time assumed a larger pool, and fewer competitors for the supply than have arisen since that time. The City intends to request an allocation, and the volume of the request will be re-evaluated in the next two to three years.

Under the settlement, the allocations will be made in blocks of one-third of the total volume with the first distribution occurring in 2010. This water was previously allocated to irrigation districts that later relinquished their allocations as part of the settlement. This agricultural priority water is subject to a complete cutback during future CAP shortages. Therefore, those receiving the allocations may need to firm the supply with backup wells, recharge credits or other reliable sources to "drought proof" the source. Those receiving allocations will be responsible for the payback of prior capital charges and other related expenses incurred by CAP in holding this supply over the years.

Additional Native American Community CAP Leases | The City maintains lease agreements with several Indian communities in Arizona for CAP supplies. Indian communities have been awarded substantial volumes of CAP, primarily for agricultural use. Though known volumes available for lease have been memorialized in settlement agreements, it is likely that additional supplies could be made available for municipal leases in the future.

"Mainstem" Colorado River Rights | Colorado River water held by irrigation districts and Indian Communities along the mainstem of the River has been cited as a potentially available source for permanent acquisition by central Arizona municipalities. If this supply is to be used for growth accommodation, institutional issues such as CAP canal capacity constraints and NEPA compliance would need to be addressed.

Dry Year "Land Fallowing" Options | Execution of land fallowing agreements with one or more irrigation districts along the mainstem of the Colorado River could provide additional water supplies during shortage years. Such arrangements could involve compensation to farmers to cover fixed costs and foregone profits. The cost of this approach could be favorable compared to the drilling, equipping and maintenance of "standby" wells in the service area. These options could be directly negotiated by Phoenix, but a collaborative approach, perhaps involving the CAP on behalf of M&I customers, may be more practical.



APPROACH 5 | ESTABLISH EXCHANGE PARTNERSHIPS

Each water purveyor is faced with unique opportunities and constraints in meeting water production and distribution objectives. Phoenix maintains substantial treatment plant capacity, but could benefit from additional well capacity and recharge in the service area. Other entities may maintain CAP allocations, but lack treatment capacity. Some of these entities may maintain abundant well capacity and access to shallow groundwater supplies. In searching for solutions that leverage strengths of multiple entities for collective benefits, Phoenix may consider benefits that may arise from exchange partnerships.

Aquifer Management Exchange | Phoenix would benefit from additional CAP storage in portions of its service area (in particular, north of the CAP canal). However, as Phoenix commits greater volumes of its CAP allocation over time to service-area demand, excess availability for recharge will diminish. In portions of the Southeast and Southwest Valley, high water table conditions (due to low pumping rates and high infiltration) limit opportunities for recharge. Opportunities may exist for Phoenix to partner with entities experiencing these high water table conditions. Groundwater (which would likely require treatment) could be pumped from the shallow upper aquifer and utilized within the entity's service area. Some or all of the entity's CAP allocation would be stored in areas of deep water table conditions (such as the Northeast Area Aquifer). Water pumped by the entity would be characterized as recovered CAP.

Groundwater Capacity Exchange | As an alternative to developing additional well capacity in the Phoenix service area, the City could partner with other entities that maintain excess well capacity. Agreements could be reached which would allow the entity's CAP available supplies to be delivered to Phoenix treatment plants during surface water shortage conditions. In exchange, the entity would pump groundwater (which would be legally characterized as CAP). Terms of the agreement would consider the relative balance of costs and benefits between the parties.

APPROACH 6 | SHARPEN THE FOCUS OF DEMAND MANAGEMENT EFFORTS

Demand management programs may be designed to effect both long-term "lifestyle" conservation, as well as more immediate reductions due to events such as drought or system emergencies. Gains from conservation are typically permanent and can either provide a supply buffer (to reduce shortage vulnerability) or the savings can offset the costs for developing supplies. Shortage-driven reductions, on the other hand, are considered a "last resort" tool to manage low probability/low frequency incidents. Redundancy to avoid such "last resort" incidents would likely entail significant expense.

Conservation | Phoenix's Water Conservation Program is an integral component in water resource portfolio management. The City has maintained an active water conservation program since 1982 that has brought numerous benefits and allowed the City to maintain compliance with mandatory conservation targets established by ADWR. The per capita rate in recent years is in the range of 208 to 225 GPCD (depending on annual weather variations) – a roughly 20 percent reduction over early 1980 rates.

Permanent reductions in demand due to conservation have resulted in substantial avoided costs to the City and customers. For example, if Phoenix customers had continued to use water today at 1980 per-capita levels, another 90,000 AF would be needed annually. In addition to reduced supply acquisition costs, savings have accrued due to reduced capital, operations and maintenance expenditures.

The Conservation Program is multi-faceted and achieves savings through public education, residential and industrial water use audits, low-income retrofit programs, media (most prominently through the regional program "Water Use it Wisely") and ordinances. As the City seeks further gains in conservation savings, efforts will be made to develop a more robust program that reflects both advancements in technology and a greater public sentiment for efficient use of natural resources. The guiding principals behind an updated conservation program will continue to involve: 1) rigorous promotion of voluntary actions by customers which reflect and enhance the southwestern low water use lifestyle; 2) a "partnership ethic" between the City and its citizens to achieve water supply sustainability; and 3) the "hard wiring" of conservation practices in new construction and in new landscape through supporting ordinances.

Drought Response | Phoenix first adopted a Drought Management Ordinance in 1990, outlining specific actions to be implemented in stages during water supply shortages. Components included increased public information and educational efforts, voluntary and mandatory conservation measures for the City and its residential, commercial and industrial water users, and a water rate surcharge to encourage reductions and to cover increased water costs and lost revenues due to drought programs. The drought ordinance and plan were revised in 2000, and now addresses localized water supply shortages caused by water distribution system failures or deficiencies as well as system-wide supply cutbacks.

The drought plan's water demand management programs are an important part of the City's strategy for reducing surface water shortage impacts. The exact degree to which overall system-wide water demand in Phoenix can be reduced during future shortages through aggressive implementation of these programs is not known. Experiences of western U.S. municipalities in recent decades demonstrate the potential for short-term water use reductions between 25 to 40 percent. However, large reductions in water use for extended periods would likely result in adverse impacts to the local economy. As Phoenix seeks to develop a comprehensive "drought response program" through a combination of supply enhancements and customer demand reductions to mitigate shortages, these potential economic impacts will be a key consideration.

Conservation, Growth and Drought Preparedness | An accepted impact from conservation programs is a phenomenon referred to as "demand hardening" which can occur when efficiency savings are allocated for growth (either directly or indirectly). In effect, demand hardening reduces the buffer separating more essential customer needs from the less essential uses. Thus, water use curtailments, when necessary due to severe surface water shortages, would be felt more significantly by customers, especially with regard to outdoor water use. To equalize these impacts, a higher degree of system and supply redundancy may be warranted. Customers could also be encouraged to plan landscaping in a manner that reduces exposure to shortages (discussed below).

An essential element of both the Drought Response and Conservation Programs is to encourage actions today that reduce or eliminate impacts during future shortfalls. One example involves encouraging customers to landscape (xeriscape) with drought tolerant trees and shrubs (those that may survive for extended periods without water). Customers could also be encouraged to prepare a "landscape triage" plan which would involve configuring water systems to curtail water delivered to lower value landscaping while continuing to support higher value varieties. Reduction of system losses and improved metering will also contribute to savings.

The following tables summarize various supply and demand management strategies to be considered in developing the functional plans.

TABLE 6-1

FUTURE SUPPLY OPTIONS		
SOURCE/STRATEGY	**OPPORTUNITIES**	**CONSTRAINTS**
Safe-Yield Groundwater	•Good physical availability in most parts of service area •Groundwater Code supports use for drought mitigation •Wells could serve multiple goals—system flexibility/ peaking, drought, credit recovery, emergencies •Potential use of sites containing disconnected wells •Potential for collaboration with SRP for use of "stranded" SRP wells/sites •Potential for exchange with other entities with excess groundwater production capacity	•Wellhead treatment needed in many cases •Site acquisition costs •Standby costs •Potential significant cumulative impacts of pumping by Phoenix and others during drought •Volume limited to that which is allowable under Assured Water Supply designation
McMullen Valley – Imported Groundwater	•Transfer authorized under Groundwater Code •Substitutes directly for depleted surface water •Deliverable to treatment plants via CAP Canal •Not necessary to install wellhead treatment •Stable during drought •Substantial reserves (158 years) •"Interim set aside" of excess canal capacity was awarded by CAP Board in 2002 •If used for CAP shortage mitigation, existing CAP canal capacity could be utilized •Lower well standby costs	•Pipeline right-of-way acquisition •Formal CAP canal wheeling agreement needed •Potential environmental impacts •Potential need to treat prior to blending with CAP •Local area concerns regarding depletion •O&M costs •NEPA compliance •Finalize CAP wheeling agreement
ASLD CAP	•Committed to Phoenix by ASLD in 1986 for State lands not covered by Phoenix CAP Subcontract •Deliverable to treatment plants via CAP Canal (uses existing infrastructure) •Subject to AWBA firming during shortages	•Portion of shortage may not be covered by AWBA •Institutional barriers in acquiring the supply
Reclaimed Water – Direct Delivery	•Stable/reliable source •Supply increases proportional to demand •Potential for underground storage/recovery •Exchange for farming or industrial uses •Offsets demands on potable system •Regulatory incentives •Potential for local "skimming" facilities to increase potential reclaimed water customers •Long term potential for complete purification and delivery to meet potable demands	•Logistics of piping to non-potable uses in Phoenix •Available volume varies seasonally •Use of current "three-way" exchange and RID Groundwater Savings Facility strategies will diminish as agricultural land is developed •Public perception and regulatory barriers limit use for potable demands
Groundwater capacity for CAP stored in Phoenix	•Provides supplemental supply to support sustainability of groundwater in Phoenix	•Exchange partners would need sufficient capacity for both their own needs and for the exchange during shortages

TABLE 6-2

RECHARGE AND RECOVERY OPTIONS		
SOURCE/STRATEGY	**OPPORTUNITIES**	**CONSTRAINTS**
CAP – within Service Area (example: Reach 11)	•Excess CAP allocation available for 5-15 years •Storage north of CAP canal would benefit existing wells •Aquifer storage and Recovery (ASR) wells would serve dual purposes •Potential to accommodate storage of other entities CAP supplies within Phoenix via exchange •Existing wells available for limited recovery under normal conditions	•Additional well capacity needed to make the supply usable in future years •Facility siting within Phoenix (land availability, potential mounding) •Impact of regional pumping on the aquifer
CAP – Outside Service Area	•Excess allocation available for 5-15 years •Phoenix holds storage permits at 2 facilities – GRUSP (direct) and SRP's GSF (indirect) •Potential for storage at other facilities in the Phoenix AMA to increase flexibility •Existing wells available for limited recovery under normal conditions	•No direct access to water stored outside of service area
Reclaimed water – storage at CCWRP Site	•Permit issued (2005) •Equalizes supply and reclaimed water system demands in North Cave Creek Area •Off-site recovery reduces distribution system expansion costs	•Recovery wells need to be designated/drilled •High relative cost of distribution system (dispersed demand)
Reclaimed water – Underground storage at Agua Fria Linear Recharge Project; recovery in service area	•Eliminates seasonal availability issues with reclaimed water •Potential for underground storage/recovery •Exchangeable for farming or industrial uses •Regulatory incentives •Federal cost sharing •Costs divided among multiple partners •Opportunities for exchanges among partners to improve recovery access	•Substantial cost of project largely due to acquisition of pipeline right-of-way through developed areas •NEPA Compliance (EIS underway) •Additional well capacity needed to make the supply usable in future years •Institutional hurdles (Phoenix is one of many participants/ stakeholders)
Roosevelt Irrigation District Groundwater Savings Facility	•Currently permitted •Serves Rio Salado habitat restoration project •Potential for expansion as 23rd Avenue facility expands •Inexpensive (capital and O&M)	•Limited term due to expected decline in agricultural demand over time

TABLE 6-3

SUPPLEMENTAL SUPPLY OPTIONS		
SOURCE/STRATEGY	**OPPORTUNITIES**	**CONSTRAINTS**
Dry Year Options (Land fallowing) – Colorado River Main stem	• Main stem rights generally higher priority than CAP • Lower cost than land/water right purchase • Potential to "package" with other CAP insurance (e.g., AWBA) • Deliverable to treatment plants via CAP Canal	• Negotiations/administration could be complex • Issues regarding transport of non-project water through CAP Canal • Long-term availability uncertain due to farmland urbanization
Dry Year Options (Land fallowing) – Indian communities	• Lower cost than land/water right purchase • Potential to "package" with other CAP insurance (e.g., AWBA) • Deliverable to treatment plants via CAP Canal	• Negotiations/administration could be complex • Issues regarding transport of non-project water through CAP Canal • Long-term availability uncertain due to farmland urbanization • NEPA compliance
Ag. Priority CAP Reallocation (potential)	• Deliverable to treatment plants via CAP Canal • Could be stored in normal years, recovered during shortfalls	• Not reliable unless firmed or used in conjunction with recharge/recovery • Allocation process will be competitive • Allocations will be established over a long period
Additional Indian Lease Water (potential)	• Deliverable to treatment plants via CAP Canal	• Availability/cost uncertain at this time • Limited term (not a permanent supply) • Firming may be necessary

TABLE 6-4

EXCHANGE OPTIONS		
SOURCE/STRATEGY	**OPPORTUNITIES**	**CONSTRAINTS**
SRP/RID/Phoenix “Three-way” exchange	• Currently in place • Efficient means to convert effluent to a surface water supply deliverable to treatment plants on SRP canal	• Limited term due to expected decline in agricultural demand over time • Not available in years when SRP needs additional well capacity for shareholder deliveries
Remote groundwater capacity for CAP delivery to plants	• Reduces need for wells in Phoenix service area • May reduce costs for other providers lacking access to CAP	• Exchange partners would need sufficient capacity for both their own needs and for the exchange during shortages
Groundwater capacity for CAP stored in Phoenix	• Provides supplemental supply to support sustainability of groundwater in Phoenix • May reduce costs for other providers lacking access to CAP	• Exchange partners would need sufficient capacity for both their own needs and for the exchange during shortages

Central City Neighborhood

TABLE 6-5

DEMAND MANAGEMENT - CONSERVATION		
SOURCE/STRATEGY	**OPPORTUNITIES**	**CONSTRAINTS**
Develop new ordinances that address new development	•New construction provides the greatest opportunity for built-in water savings	•Difficulty in addressing a wide range of non-residential (commercial and industrial) water uses
Develop an advanced landscape professional training program	•Widespread benefits from professionals who are better informed as to how to assist their clients in reducing water use	•Ability to reach large numbers of professionals who can apply these principles
Monitor mid-sized land-scaped areas which fall below the current 10 acre regulatory threshold	•May bring savings from more efficient practices at schools, parks, common areas and other facilities	•Water saving benefits may not warrant the cost of administering the program (an evaluation will be necessary to make this determination)
For restaurants, retrofit with low-water use/high-pressure pre-rinse nozzles	•Opportunity to monitor actual savings •Lower water and energy costs	•Costs to City in relation to potential water savings benefits
Expand the plumbing retrofit program to include outdoor-water use audits	•Addresses neighborhoods where assistance is most needed •Education	•Any related cash investment may be difficult for limited income households
Expansion of the City's current conservation marketing program	•Customer exposure to conservation messages has positively impacted behavioral patterns related to water use	•Unknown potential for further significant "lifestyle" conservation savings commensurate with earlier achievements •Confusion between conservation and drought response
Video Workshops on a variety of conservation topics	•Ability to reach a much larger number of customers for the investment	•Unknown practical response (in terms of water savings) to these videos
High-user surcharges (in basic rate structure)	•Incentive to conserve •Could provide a revenue source for conservation or water resources programs	•Potential impact to low-income users •High-income users may not respond by conserving

TABLE 6-4

DEMAND MANAGEMENT - DROUGHT RESPONSE		
SOURCE/STRATEGY	**OPPORTUNITIES**	**CONSTRAINTS**
Drought Surcharge	•Encourages demand reduction, generates revenue for enforcement and further drought response actions	• Potential impact to low income users • High-income users may not respond by reducing water use
Re-landscape with drought-tolerant species, when possible	•Built-in drought response (avoids need for significant cutbacks later) •Could be encouraged with rebates	• Could be costly if significant rebates are needed to incent conversion (most successful programs require such incentives)
Refrain from overseeding lawns	•Visible drought response measure (instills an ethic of reducing water use during drought) •Reduces lawn care & maintenance	• May not significantly affect overall water use as winter demand is low • Economic impacts to turf industry customers • Quality of life concerns for residential customers
Limit turf watering be-tween specific hours	•Easy to understand •Avoids peak evening & morning indoor usage	• Enforcement challenges • Difficult to quantify savings
Day of week watering restrictions	•Easy to communicate to customers •Opportunity to educate customers regarding actual plant needs	• Perceived threat to viability of lawns • Some customers lack irrigation controllers • Could affect overall system management • Manpower required to adequately enforce
Refrain from washing sidewalks & driveways with water	•Visible drought response measure	• Enforcement challenges • Insignificant direct savings in relation to manpower needed to enforce
Refrain from operating public and private decorative water fea-tures, such as fountains	•Visible drought response measure	• Insignificant direct savings
Robust enforcement of existing "water in the street" ordinance	•Addresses a visible sign of water waste	• Manpower required to adequately enforce Insignificant direct savings

PLAN IMPLEMENTATION AND RELATED COSTS

Development of the functional plans described in this chapter is the major focus of plan implementation actions over the next two years. These plans, some of which will be developed concurrently, will involve team efforts involving Water Services staff expertise and other professionals. The results will represent a detailed extension of this 2005 Water Resources Plan Update.

Cost estimates for many of the alternative supply and infrastructure strategies are being developed in conjunction with the evaluation of the Water Resource Acquisition Fee Program. As these costs and related benefits of each strategy become more fully developed, the appropriate mix of supplies and a phase-in schedule will be established.

CONCLUSION

In recent years and over past decades, the City of Phoenix has taken decisive actions in acquiring and managing water resources to provide for the City's future. The result of these efforts has positioned the City of Phoenix to respond to growth and drought-related challenges. The efforts and approaches advanced through this Water Resources Plan Update will further ensure the long-term reliability of Phoenix's water supply for the benefit of current and future generations.

APPENDICES

PHOENIX WATER RESOURCES PLAN UPDATE 2005

APPENDIX A

LAND USE PROFILE EXAMPLE

The following example was extracted from a report prepared for the City by HDR, Inc. which aided in establishing seven alternative growth scenarios used to analyze the sensitivity of Phoenix supplies to various growth patterns. This particular land use profile was used as a basis for the high-density growth scenario, which served as the high-demand extreme evaluated in this Plan.

"Transit"[1] | On November 2, 2004 Maricopa County residents voted for a 20 year, 1/2 cent sales tax extension of a $16 billion regional transportation plan on the November ballot. Fifty Five percent of these funds will be used to pay for new freeways; eight percent will be used to improve or build city streets and 15% will be spend on bus transit, Rapid Bus and Dial A Ride. Twenty-seven miles of extensions of the Valley Metro Rail light rail system are also funded through the initiative, bringing the total to 58 miles of light rail in the Metropolitan Phoenix area by 2025. Some funding ($5 million) has been set aside for commuter rail studies.

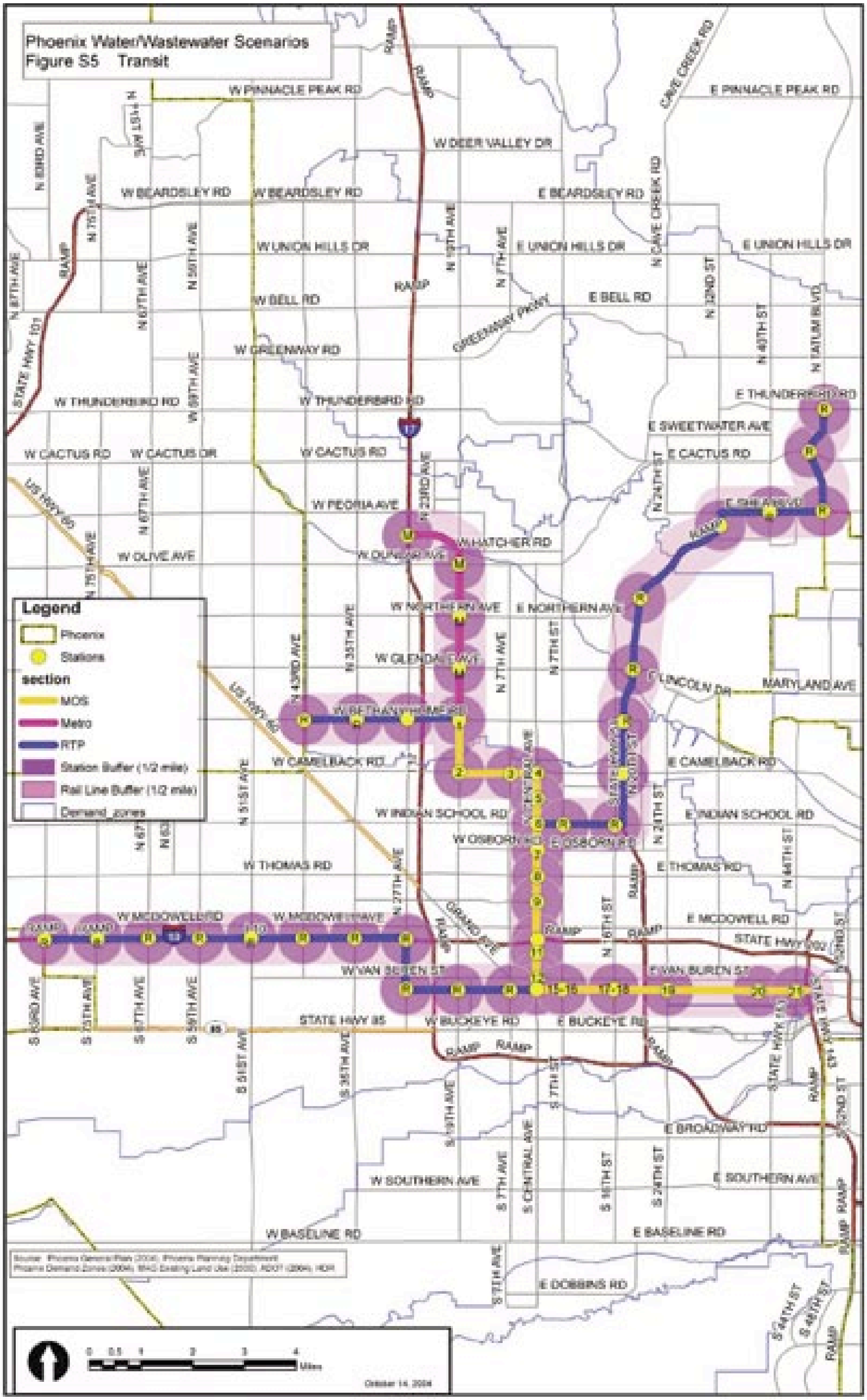
The "transit" scenario envisions that over 42 miles of light rail will be built in Phoenix by 2025, with a total of 47 transit stops. With the development of light rail it is envisioned that redevelopment will occur in the vicinity of the transit lines and stops. For this scenario, the above referenced transit stops and rail lines were buffered 1⁄2 mile to determine the focus areas.

This scenario explores two alternative transit scenarios, a moderate redevelopment series and a high redevelopment series. In the moderate redevelopment series, limited areas of redevelopment are allowed to occur around each of the transit stations (areas within the 1⁄2 mile buffer of the transit stations), and higher density within the transit line buffers until the year 2025. After the year 2025, the moderate redevelopment series forces 50% of the remaining land to be redeveloped by the year 2055.

In the high redevelopment series transit scenario, 100% of the land around transit stations (areas within the 1⁄2 mile buffer of the transit stations) is redeveloped at higher densities with more intense uses. Again, as in the moderate redevelopment series, densities are increased in the area of the transit line buffer areas as well.

This scenario also envisions that employment densities surrounding rail stations and rail line corridors will be at 100% occupancy.

[1]Information for the Transit Scenario was provided by the Phoenix Planning Department and modeled by the Maricopa Association of Governments. The "story line" was written by HDR and based on information provided by the aforementioned agencies.


Phoenix Water/Wastewater Scenarios
Figure S5 Transit
Legend
Phoenix
Stations
section
MOS
Metro
RTP
Station Buffer (1/2 mile)
Rail Line Buffer (1/2 mile)
Demand_zones
0 0.5 1 2 3 4
Miles
October 14, 2004

SENARIO GUIDANCE	TRANSIT
Definition of Scenario:	The light rail system is developed beyond the currently planned system.
Influences that could create this scenario:	•Electronic Commerce Continues to increase. •Light Rail Completed In Valley. •Gas Prices Rise For 20th Year In A Row!
Rationale:	To examine the impacts to water and wastewater demands in the City of Phoenix when transit is developed beyond the currently envisioned system.
Factors considered when identifying these centers:	•Land values near transportation corridors. •Future transportation bonds, Capital Improvement Programs. •Vehicle miles traveled. •Higher densities near service areas. •Broadband/Fiber optics. •Unobstructed satellite dish space. •Redundant power sources •Continued use/reuse of suburban style office parks. •New garden office parks in suburban portions of City. •Mixed use development adjacent to transportation nodes. •Spoke and Hub type development.
MAG Assumptions (see memo dated 10/12/04)	•Land use and density changes applied to an area of half-mile radius surrounding the stations. •Current Light Rail line alignment and station locations from RPTA used for Minimum Operating (MOS) segment. For Metro Center Extension and RTP segments; stations assumed to be located at all major intersections. •Changes to land use and density surrounding the stations along the MOS segment in Phoenix (approx. 13 mi.) based on changes recommended by Phoenix Planning. a. Stations 4-16 i.High Rise section with FAR= 4.0 ii.Mixed Use with – 60% Residential, 10% Retail, 20% Office, 10% Other iii. Redevelopment Potential = 44 ac. b. Stations 1-3 and 17-21 i. 3-5 Story section with FAR= 2.0 ii.Mixed Use with – 50% Residential, 16% Retail, 27% Office, 7% Industrial iii. Redevelopment Potential: Stations 1-3 = 44 ac.; c. Stations 17-21 = 170ac.

SENARIO GUIDANCE	TRANSIT
MAG Assumptions (see memo dated 10/12/04)	•Changes to land use and density surrounding the stations along the Phoenix Metro Center Extension (approx. 7 mi.) and the RTP Light Rail segments in Phoenix (approx. 22 mi.) based on changes recommended by Phoenix Planning for 3-5 Story section with redevelopment potential = 44ac. •Employment densities surrounding stations and corridor at 100% occupancy. •Public employment ratio per resident for Phoenix MPA held constant. •High-Moderate-Low Redevelopment Series: a.High Redevelopment Series = 100% redevelopment surrounding all stations; higher densities along the corridor; Phoenix MPA control total not maintained. b.Moderate Redevelopment Series = redevelopment as recommended by Phoenix Water surrounding all stations and higher densities along corridor. Same as Low series till 2025; beyond 2025, 50% of remaining land redeveloped by 2055. c. Low Redevelopment Series = redevelopment as recommended by Phoenix Planning s urrounding all stations; higher densities along corridor; Phoenix MPA control total not maintained. •Timing: a.Rail line completion timing derived from RPTA for MOS and Metro Center extension. Timing for RTP Segments derived from RTP. b.Timing for land use and density changes – 25% pre-construction (5 yr. before completion); 50% short-term post construction (5 yr. after construction); 15% mid-term post construction (5-10 yrs.); 10% extended-term (10-20 yrs.).
Assumptions:	Share: Maintained Control Totals: Maintained •Land values are estimated to increase within close proximity to light-rail transit, warranting redevelopment of these areas. •Higher-intensity development also provides landowners with the financial incentive to redevelop low-intensity uses. •Investment along planned rail increases substantially adjacent to transportation corridors and in existing and planned office areas close to or integrated with developed residential.
Focus Areas for Land Use Modifications:	Refer to Figure S5.

TABLE 7 - SCENARIO 5: "TRANSIT," SUMMARY OF LAND USE CHARGES

	NUMBER/LENGTH	ACRES
Transit Stops (1/2 mile buffer)	47 Transit Stops	20,538.8
Transit Lines (1/2 mile buffer)		6,597.1
Minimum Operating Segment (Complete 2008)	11.98	
Metro Phase 1(2005-2010)	4.33	
RTP Phase 3 (2016-2020)	13.48	
RTP Phase 4 (2021-2025)	12.58	
	Sum of Change Acres	**27,135.9**

APPENDIX B
WATER BUDGET AND PROJECTION DETAILS

SCENARIO A: Normal Supply Conditions, General Plan-Based Growth

(Figures expressed in 1,000 acre-feet)

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055
COLORADO RIVER AVAILABILITY											
Normal Year AZ Allocation	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
Shortage Reduction Volume for AZ	0	0	0	0	0	0	0	0	0	0	0
Net Colorado R.Supply Available to AZ	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
Pre-1968 Colorado River Supply (Priority 1, 2 and 3)	1,204	1,244	1,248	1,253	1,258	1,263	1,268	1,273	1,278	1,284	1,284
Priority 4 Colorado River Supply Available	1,596	1,556	1,552	1,547	1,542	1,537	1,532	1,527	1,522	1,516	1,516
P4 River Demand (consumptive use)	81	105	108	111	114	116	117	119	120	122	122
CAP P4 Demand before loss	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436
CAP P4 Supply after loss	1,444	1,379	1,372	1,365	1,357	1,350	1,343	1,337	1,330	1,323	1,323
New Mexico Demand	0	0	0	0	18	18	18	18	18	18	18
Priority 4 Colorado River water available to CAP	1,444	1,379	1,372	1,365	1,339	1,332	1,325	1,319	1,312	1,305	1,305
M&I CAP Demand	479	602	639	639	639	639	639	639	686	686	686
CAP - M&I Supply	479	602	639	639	639	639	639	639	686	686	686
CAP - M&I Shortage	0	0	0	0	0	0	0	0	0	0	0
Indian CAP Demand	62	199	314	336	340	343	343	343	343	343	343
P4 Indian Supply	62	199	314	336	340	343	343	343	343	343	343
CAP - Indian Supply (Adjusted)	62	199	314	336	340	343	343	343	343	343	343
CAP - Indian Shortage	0	0	0	0	0	0	0	0	0	0	0
NIA CAP Demand	64	96	104	162	216	360	365	365	317	317	317
CAP - NIA Supply	64	96	104	162	216	350	344	337	283	276	276
CAP - NIA Shortage	0	0	0	0	0	10	21	28	35	42	42
Excess CAP	838	482	315	228	144	0	0	0	0	0	0
ON-PROJECT PROJECTIONS WITH CURRENT SUPPLIES											
Water Right Acres (1,000)	78	85	90	94	94	94	94	94	94	94	94
Stored and Developed Available	234	255	270	281	281	281	281	281	281	281	281
Normal Flow Available	73	79	84	87	87	87	87	87	87	87	87
Penninsula-Horowitz Available	0	2	3	3	3	3	3	3	3	3	3
Total SRP Available	307	336	356	372	372	372	372	372	372	372	372
Groundwater (Phoenix wells)	0	0	0	0	0	0	0	0	0	0	0
SUPPLY - On-Project*	179	198	206	214	218	222	223	224	224	224	224
DEMAND - On-Project	179	198	206	214	218	222	223	224	224	224	224
On-Project Surplus/(Deficit)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
OFF-PROJECT PROJECTIONS WITH CURRENT SUPPLIES											
CAP - Colorado River Exchange (Pre-1968)	5	5	5	5	5	5	5	5	5	5	5
CAP - Existing Subcontract (M&I)	114	114	114	114	114	114	114	114	114	114	114
CAP - GRIC Settlement Reallocation (M&I)	0	8	8	8	8	8	8	8	8	8	8
CAP - AWBA Shortage Insurance (limited term)	0	0	0	0	0	0	0	0	0	0	0
CAP - Fort McDowell Settlement (Indian)	4	4	4	4	4	4	4	4	4	4	4
CAP - SRPMIC Lease (Indian)	3	3	3	3	3	3	3	3	3	3	3
CAP - GRIC Indian Lease (Indian)	0	15	15	15	15	15	15	15	15	15	15
CAP - RWCD Makeup Water (NIA)	1	1	1	1	1	1	1	1	1	1	1
CAP - Hohokam ID Buyout (NIA/M&I)**	36	36	36	36	36	35	34	33	36	36	36
SRP - Horseshoe Dam Gatewater	19	19	19	19	19	19	19	19	19	19	19
SRP - Roosevelt Dam New Conservation Space	29	29	29	29	29	29	29	29	29	29	29
Reclaimed Water - RID Exchange	20	20	20	20	0	0	0	0	0	0	0
Reclaimed Water - Direct	2	5	5	5	5	5	5	5	5	5	5
Groundwater***	15	15	15	15	15	15	15	15	15	15	15
SUPPLY - Off Project	248	274	274	274	254	253	252	251	254	254	254
DEMAND - Off-Project	173	201	226	255	274	294	307	321	324	326	329
Off-Project Surplus/(Deficit)	**74**	**73**	**48**	**19**	**(20)**	**(41)**	**(55)**	**(70)**	**(70)**	**(72)**	**(75)**
COMBINED ON AND OFF PROJECT SUMMARY											
Total Current Supplies	**427**	**472**	**480**	**488**	**472**	**475**	**475**	**475**	**478**	**478**	**478**
Projected Demand	**352**	**399**	**433**	**469**	**491**	**516**	**530**	**545**	**548**	**550**	**553**
Surplus/(Deficit) - With Current Sources	**74**	**73**	**48**	**19**	**(20)**	**(41)**	**(55)**	**(70)**	**(70)**	**(72)**	**(75)**
FUTURE SUPPLY OPTIONS (DRY YEAR AND GROWTH-RELATED)											
Additional Safe-Yield Groundwater (limited term)	0	0	0	0	0	0	0	0	0	0	0
Imported Groundwater - McMullen Valley	0	0	0	0	38	38	38	38	38	38	38
Existing Underground Storage Credit Recovery (limited term)	0	0	0	0	0	0	0	0	0	0	0
CAP - ASLD- Phoenix Volume (M&I)	0	10	12	12	12	12	12	12	12	12	12
Reclaimed Water (for direct-delivery/recovery/exchange)	0	0	0	11	39	47	52	57	59	59	60
CAP - NIA Reallocation (NIA) ****	0	0	0	0	0	0	0	0	0	0	0
Total Future Supplies	**0**	**10**	**12**	**23**	**89**	**97**	**102**	**107**	**109**	**109**	**110**
DEMAND MANAGEMENT											
Net water savings (assuming aggressive conservation)*****	0	11	16	23	27	30	33	36	35	38	40
DROUGHT RESPONSE REQUIRED (ADDITIONAL DEMAND MANAGEMENT OR SUPPLEMENTAL SUPPLIES)											
Current Water Use Rate Scenario	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Aggressive Conservation Scenario	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
CURRENT SUPPLIES AND EXISTING CUSTOMERS											
Current supplies less existing customer demand	74	120	128	136	119	122	122	122	125	126	126
Assume 10 percent conservation from existing customers	-	155	163	171	155	157	157	158	161	161	161

* Available supply is limited by demand (excess supply cannot be used off project)

** Status changes from agricultural priority (non-firm) to M&I priority (firm) in 2044

*** Current capacity allows for 44,000 af/yr during periods of drought. Normal year pumpage assumed at 15,000 af (and is well within Assured Water Supply groundwater allowance)

**** Reallocation volumes not yet determined

***** Does not include water savings on-project when available SRP supplies exceed demand (the saved water remains in SRP reservoirs)

APPENDIX B
WATER BUDGET AND PROJECTION DETAILS

SCENARIO B: Normal Supply Conditions, High Density Growth

(Figures expressed in 1,000 acre-feet)

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055
COLORADO RIVER AVAILABILITY											
Normal Year AZ Allocation	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
Shortage Reduction Volume for AZ	0	0	0	0	0	0	0	0	0	0	0
Net Colorado R.Supply Available to AZ	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
Pre-1968 Colorado River Supply (Priority 1, 2 and 3)	1,204	1,244	1,248	1,253	1,258	1,263	1,268	1,273	1,278	1,284	1,284
Priority 4 Colorado River Supply Available	1,596	1,556	1,552	1,547	1,542	1,537	1,532	1,527	1,522	1,516	1,516
P4 River Demand (consumptive use)	81	105	108	111	114	116	117	119	120	122	122
CAP P4 Demand before loss	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436
CAP P4 Supply after loss	1,444	1,379	1,372	1,365	1,357	1,350	1,343	1,337	1,330	1,323	1,323
New Mexico Demand	0	0	0	0	18	18	18	18	18	18	18
Priority 4 Colorado River water available to CAP	1,444	1,379	1,372	1,365	1,339	1,332	1,325	1,319	1,312	1,305	1,305
M&I CAP Demand	479	602	639	639	639	639	639	639	686	686	686
CAP - M&I Supply	479	602	639	639	639	639	639	639	686	686	686
CAP - M&I Shortage	0	0	0	0	0	0	0	0	0	0	0
Indian CAP Demand	62	199	314	336	340	343	343	343	343	343	343
P4 Indian Supply	62	199	314	336	340	343	343	343	343	343	343
CAP - Indian Supply (Adjusted)	62	199	314	336	340	343	343	343	343	343	343
CAP - Indian Shortage	0	0	0	0	0	0	0	0	0	0	0
NIA CAP Demand	64	96	104	162	216	360	365	365	317	317	317
CAP - NIA Supply	64	96	104	162	216	350	344	337	283	276	276
CAP - NIA Shortage	0	0	0	0	0	10	21	28	35	42	42
Excess CAP	838	482	315	228	144	0	0	0	0	0	0
ON-PROJECT PROJECTIONS WITH CURRENT SUPPLIES											
Water Right Acres (1,000)	78	85	90	94	94	94	94	94	94	94	94
Stored and Developed Available	234	255	270	281	281	281	281	281	281	281	281
Normal Flow Available	73	79	84	87	87	87	87	87	87	87	87
Penninsula-Horowitz Available	0	2	3	3	3	3	3	3	3	3	3
Total SRP Available	307	336	356	372	372	372	372	372	372	372	372
Groundwater (Phoenix wells)	0	0	0	0	0	0	0	0	0	0	0
SUPPLY - On-Project*	179	212	241	278	301	327	350	372	372	372	372
DEMAND - On-Project	179	212	241	278	301	327	350	374	378	382	382
On-Project Surplus/(Deficit)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	(3)	(7)	(10)	(11)
OFF-PROJECT PROJECTIONS WITH CURRENT SUPPLIES											
CAP - Colorado River Exchange (Pre-1968)	5	5	5	5	5	5	5	5	5	5	5
CAP - Existing Subcontract (M&I)	114	114	114	114	114	114	114	114	114	114	114
CAP - GRIC Settlement Reallocation (M&I)	0	8	8	8	8	8	8	8	8	8	8
CAP - AWBA Shortage Insurance (limited term)	0	0	0	0	0	0	0	0	0	0	0
CAP - Fort McDowell Settlement (Indian)	4	4	4	4	4	4	4	4	4	4	4
CAP - SRPMIC Lease (Indian)	3	3	3	3	3	3	3	3	3	3	3
CAP - GRIC Indian Lease (Indian)	0	15	15	15	15	15	15	15	15	15	15
CAP - RWCD Makeup Water (NIA)	1	1	1	1	1	1	1	1	1	1	1
CAP - Hohokam ID Buyout (NIA/M&I)**	36	36	36	36	36	35	34	33	36	36	36
SRP - Horseshoe Dam Gatewater	19	19	19	19	19	19	19	19	19	19	19
SRP - Roosevelt Dam New Conservation Space	29	29	29	29	29	29	29	29	29	29	29
Reclaimed Water - RID Exchange	20	20	20	20	0	0	0	0	0	0	0
Reclaimed Water - Direct	2	5	5	5	5	5	5	5	5	5	5
Groundwater***	15	15	15	15	15	15	15	15	15	15	15
SUPPLY - Off Project	248	274	274	274	254	253	252	251	254	254	254
DEMAND - Off-Project	173	196	219	245	265	288	308	329	333	336	339
Off-Project Surplus/(Deficit)	**74**	**78**	**55**	**29**	(11)	(35)	(56)	(78)	(79)	(83)	(85)
COMBINED ON AND OFF PROJECT SUMMARY											
Total Current Supplies	427	472	480	488	472	475	475	475	478	478	478
Projected Demand	352	399	433	469	491	515	530	545	548	550	563
Surplus/(Deficit) - With Current Sources	**74**	**78**	**55**	**29**	(11)	(35)	(56)	(81)	(86)	(93)	(96)
FUTURE SUPPLY OPTIONS (DRY YEAR AND GROWTH-RELATED)											
Additional Safe-Yield Groundwater (limited term)	0	0	0	0	0	0	0	0	0	0	0
Imported Groundwater - McMullen Valley	0	0	0	0	38	38	38	38	38	38	38
Existing Underground Storage Credit Recovery (limited term)	0	0	0	0	0	0	0	0	0	0	0
CAP - ASLD- Phoenix Volume (M&I)	0	10	12	12	12	12	12	12	12	12	12
Reclaimed Water (for direct-delivery/recovery/exchange)	0	0	8	30	65	82	97	113	116	118	119
CAP - NIA Reallocation (NIA) ****	0	0	0	0	0	0	0	0	0	0	0
Total Future Supplies	0	10	20	42	115	132	147	163	166	168	169
DEMAND MANAGEMENT											
Net water savings (assuming aggressive conservation)*****	0	6	9	13	15	17	19	23	28	32	32
DROUGHT RESPONSE REQUIRED (ADDITIONAL DEMAND MANAGEMENT OR SUPPLEMENTAL SUPPLIES)											
Current Water Use Rate Scenario	0	0	0	0	0	0	0	0	0	0	0
Aggressive Conservation Scenario	0	0	0	0	0	0	0	0	0	0	0
CURRENT SUPPLIES AND EXISTING CUSTOMERS											
Current supplies less existing customer demand	74	120	128	136	119	122	122	122	125	126	126
Assume 10 percent conservation from existing customers	-	155	163	171	155	157	157	158	161	161	161

* Available supply is limited by demand (excess supply cannot be used off project)

** Status changes from agricultural priority (non-firm) to M&I priority (firm) in 2044

*** Current capacity allows for 44,000 af/yr during periods of drought. Normal year pumpage assumed at 15,000 af (and is well within Assured Water Supply groundwater allowance)

**** Reallocation volumes not yet determined

***** Does not include water savings on-project when available SRP supplies exceed demand (the saved water remains in SRP reservoirs)

APPENDIX B
WATER BUDGET AND PROJECTION DETAILS

SCENARIO C: Moderate Shortage, General Plan Growth

(Figures expressed in 1,000 acre-feet)

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055
COLORADO RIVER AVAILABILITY											
Normal Year AZ Allocation	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
Shortage Reduction Volume for AZ	500	500	500	500	500	500	500	500	500	500	500
Net Colorado R.Supply Available to AZ	2,300	2,300	2,300	2,300	2,300	2,300	2,300	2,300	2,300	2,300	2,300
Pre-1968 Colorado River Supply (Priority 1, 2 and 3)	1,204	1,244	1,248	1,253	1,258	1,263	1,268	1,273	1,278	1,284	1,284
Priority 4 Colorado River Supply Available	1,096	1,056	1,052	1,047	1,042	1,037	1,032	1,027	1,022	1,016	1,016
P4 River Demand (consumptive use)	81	105	108	111	114	116	117	119	120	122	122
CAP P4 Demand before loss	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436
CAP P4 Supply after loss	966	913	907	901	895	889	883	877	871	865	865
New Mexico Demand	0	0	0	0	18	18	18	18	18	18	18
Priority 4 Colorado River water available to CAP	966	913	907	901	877	871	865	859	853	847	847
M&I CAP Demand	479	602	639	639	639	639	639	639	686	686	686
CAP - M&I Supply	479	602	592	578	560	556	552	547	543	539	539
CAP - M&I Shortage	0	0	47	61	79	83	87	92	143	147	147
Indian CAP Demand	62	199	314	336	340	343	343	343	343	343	343
P4 Indian Supply	62	199	324	322	316	315	313	312	310	308	308
CAP - Indian Supply (Adjusted)	62	199	314	322	316	315	313	312	310	308	308
CAP - Indian Shortage	0	0	0	13	24	28	30	31	33	35	35
NIA CAP Demand	64	96	104	162	216	360	365	365	317	317	317
CAP - NIA Supply	64	96	0	0	0	0	0	0	0	0	0
CAP - NIA Shortage	0	0	104	162	216	360	365	365	317	317	317
Excess CAP	361	15	0	0	0	0	0	0	0	0	0
ON-PROJECT PROJECTIONS WITH CURRENT SUPPLIES											
Water Right Acres (1,000)	78	85	90	94	94	94	94	94	94	94	94
Stored and Developed Available	234	170	180	188	188	188	188	189	188	188	188
Normal Flow Available	73	54	58	60	60	60	60	60	60	60	60
Penninsula-Horowitz Available	0	2	3	3	3	3	3	3	3	3	3
Total SRP Available	307	226	240	251	251	251	251	251	251	251	251
Groundwater (Phoenix wells)	0	0	0	0	0	0	0	0	0	0	0
SUPPLY - On-Project*	179	198	206	214	218	222	223	224	224	224	224
DEMAND - On-Project	179	198	206	214	218	222	223	224	224	224	224
On-Project Surplus/(Deficit)	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
OFF-PROJECT PROJECTIONS WITH CURRENT SUPPLIES											
CAP - Colorado River Exchange (Pre-1968)	5	5	5	5	5	5	5	5	5	5	5
CAP - Existing Subcontract (M&I)	114	114	106	103	100	99	96	95	90	90	90
CAP - GRIC Settlement Reallocation (M&I)	0	8	8	7	7	7	7	7	6	6	6
CAP - AWBA Shortage Insurance (limited term)	0	0	9	12	15	16	17	18	32	32	32
CAP - Fort McDowell Settlement (Indian)	4	4	4	4	4	4	4	4	4	4	4
CAP - SRPMIC Lease (Indian)	3	3	3	3	3	3	3	3	3	3	3
CAP - GRIC Indian Lease (Indian)	0	15	15	13	13	13	13	13	12	13	13
CAP - RWCD Makeup Water (NIA)	1	1	0	0	0	0	0	0	0	0	0
CAP - Hohokam ID Buyout (NIA/M&I)**	36	36	0	0	0	0	0	0	29	28	28
SRP - Horseshoe Dam Gatewater	19	0	0	0	0	0	0	0	0	0	0
SRP - Roosevelt Dam New Conservation Space	29	0	0	0	0	0	0	0	0	0	0
Reclaimed Water - RID Exchange	20	0	0	0	0	0	0	0	0	0	0
Reclaimed Water - Direct	2	5	5	5	5	5	5	5	5	5	5
Groundwater***	0	10	44	44	44	44	44	44	44	44	44
SUPPLY - Off Project	233	201	198	197	196	196	196	196	231	230	230
DEMAND - Off-Project	173	201	226	255	274	294	307	321	324	326	329
Off-Project Surplus/(Deficit)	**59**	**0**	(23)	(58)	(77)	(98)	(111)	(125)	(93)	(96)	(99)
COMBINED ON AND OFF PROJECT SUMMARY											
Total Current Supplies	412	399	405	411	414	418	419	420	455	454	454
Projected Demand	352	399	433	469	491	516	530	545	548	550	553
Surplus/(Deficit) - With Current Sources	**59**	**0**	(23)	(58)	(77)	(98)	(111)	(125)	(93)	(96)	(99)
FUTURE SUPPLY OPTIONS (DRY YEAR AND GROWTH-RELATED)											
Additional Safe-Yield Groundwater (limited term)	0	0	30	30	30	30	30	30	30	30	30
Imported Groundwater - McMullen Valley	0	0	0	38	38	38	38	38	38	38	38
Existing Underground Storage Credit Recovery (limited term)	0	0	0	0	0	10	10	10	0	0	0
CAP - ASLD- Phoenix Volume (M&I)	0	10	11	11	11	10	10	10	10	10	10
Reclaimed Water (for direct-delivery/recovery/exchange)	0	7	18	31	39	47	52	57	59	59	60
CAP - NIA Reallocation (NIA) ****	0	0	0	0	0	0	0	0	0	0	0
Total Future Supplies	0	17	59	110	117	136	141	146	137	138	139
DEMAND MANAGEMENT											
Net water savings (assuming aggressive conservation)*****	0	1	16	23	27	30	33	36	36	36	36
DROUGHT RESPONSE REQUIRED (ADDITIONAL DEMAND MANAGEMENT OR SUPPLEMENTAL SUPPLIES)											
Current Water Use Rate Scenario	0	0	0	0	0	0	0	0	0	0	0
Aggressive Conservation Scenario	0	0	0	0	0	0	0	0	0	0	0
CURRENT SUPPLIES AND EXISTING CUSTOMERS											
Current supplies less existing customer demand	59	47	52	58	62	65	66	67	102	101	102
Assume 10 percent conservation from existing customers	-	82	87	94	97	101	102	102	137	137	137

* Available supply is limited by demand (excess supply cannot be used off project)

** Status changes from agricultural priority (non-firm) to M&I priority (firm) in 2044

*** Current capacity allows for 44,000 af/yr during periods of drought. Normal year pumpage assumed at 15,000 af (and is well within Assured Water Supply groundwater allowance)

**** Reallocation volumes not yet determined

***** Does not include water savings on-project when available SRP supplies exceed demand (the saved water remains in SRP reservoirs)

APPENDIX B
WATER BUDGET AND PROJECTION DETAILS

SCENARIO D: Moderate Shortage, High DensityGrowth

(Figures expressed in 1,000 acre-feet)

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055
COLORADO RIVER AVAILABILITY											
Normal Year AZ Allocation	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
Shortage Reduction Volume for AZ	500	500	500	500	500	500	500	500	500	500	500
Net Colorado R.Supply Available to AZ	2,300	2,300	2,300	2,300	2,300	2,300	2,300	2,300	2,300	2,300	2,300
Pre-1968 Colorado River Supply (Priority 1, 2 and 3)	1,204	1,244	1,248	1,253	1,258	1,263	1,268	1,273	1,278	1,284	1,284
Priority 4 Colorado River Supply Available	1,096	1,056	1,052	1,047	1,042	1,037	1,032	1,027	1,022	1,016	1,016
P4 River Demand (consumptive use)	81	105	108	111	114	116	117	119	120	122	122
CAP P4 Demand before loss	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436
CAP P4 Supply after loss	966	913	907	901	895	889	883	877	871	865	865
New Mexico Demand	0	0	0	0	18	18	18	18	18	18	18
Priority 4 Colorado River water available to CAP	966	913	907	901	877	871	865	859	853	847	847
M&I CAP Demand	479	602	639	639	639	639	639	639	686	686	686
CAP - M&I Supply	479	602	592	578	560	556	552	547	543	539	539
CAP - M&I Shortage	0	0	47	61	79	83	87	92	143	147	147
Indian CAP Demand	62	199	314	336	340	343	343	343	343	343	343
P4 Indian Supply	62	199	324	322	316	315	313	312	310	308	308
CAP - Indian Supply (Adjusted)	62	199	314	322	316	315	313	312	310	308	308
CAP - Indian Shortage	0	0	0	13	24	28	30	31	33	35	35
NIA CAP Demand	64	96	104	162	216	360	365	365	317	317	317
CAP - NIA Supply	64	96	0	0	0	0	0	0	0	0	0
CAP - NIA Shortage	0	0	104	162	216	360	365	365	317	317	317
Excess CAP	361	15	0	0	0	0	0	0	0	0	0
ON-PROJECT PROJECTIONS WITH CURRENT SUPPLIES											
Water Right Acres (1,000)	78	85	90	94	94	94	94	94	94	94	94
Stored and Developed Available	234	170	180	188	188	188	188	189	188	188	188
Normal Flow Available	73	54	58	60	60	60	60	60	60	60	60
Penninsula-Horowitz Available	0	2	3	3	3	3	3	3	3	3	3
Total SRP Available	307	226	240	251	251	251	251	251	251	251	251
Groundwater (Phoenix wells)	0	0	0	0	0	0	0	0	0	0	0
SUPPLY - On-Project*	179	212	240	251	251	251	251	251	251	251	251
DEMAND - On-Project	179	212	241	278	301	327	350	374	378	382	382
On-Project Surplus/(Deficit)	0	0	(1)	(28)	(51)	(76)	(99)	(124)	(128)	(131)	(132)
OFF-PROJECT PROJECTIONS WITH CURRENT SUPPLIES											
CAP - Colorado River Exchange (Pre-1968)	5	5	5	5	5	5	5	5	5	5	5
CAP - Existing Subcontract (M&I)	114	114	106	103	100	99	98	98	90	90	90
CAP - GRIC Settlement Reallocation (M&I)	0	8	8	7	7	7	7	7	6	6	6
CAP - AWBA Shortage Insurance (limited term)	0	0	9	12	15	16	17	18	32	32	32
CAP - Fort McDowell Settlement (Indian)	4	4	4	4	4	4	4	4	4	4	4
CAP - SRPMIC Lease (Indian)	3	3	3	3	3	3	3	3	3	3	3
CAP - GRIC Indian Lease (Indian)	0	15	15	13	13	13	13	13	12	13	13
CAP - RWCD Makeup Water (NIA)	1	1	0	0	0	0	0	0	0	0	0
CAP - Hohokam ID Buyout (NIA/M&I)**	36	36	0	0	0	0	0	0	29	28	28
SRP - Horseshoe Dam Gatewater	19	0	0	0	0	0	0	0	0	0	0
SRP - Roosevelt Dam New Conservation Space	29	0	0	0	0	0	0	0	0	0	0
Reclaimed Water - RID Exchange	20	0	0	0	0	0	0	0	0	0	0
Reclaimed Water - Direct	2	5	5	5	5	5	5	5	5	5	5
Groundwater***	0	5	44	44	44	44	44	44	44	44	44
SUPPLY - Off Project	233	196	198	197	196	196	196	196	231	230	230
DEMAND - Off-Project	173	196	219	245	265	288	308	329	333	336	339
Off-Project Surplus/(Deficit)	59	0	(21)	(48)	(69)	(92)	(112)	(133)	(102)	(107)	(109)
COMBINED ON AND OFF PROJECT SUMMARY											
Total Current Supplies	412	408	438	447	447	447	447	447	481	480	480
Projected Demand	352	408	460	523	567	615	657	703	711	718	721
Surplus/(Deficit) - With Current Sources	59	0	(22)	(76)	(120)	(169)	(211)	(257)	(230)	(238)	(241)
FUTURE SUPPLY OPTIONS (DRY YEAR AND GROWTH-RELATED)											
Additional Safe-Yield Groundwater (limited term)	0	0	30	30	30	30	30	30	30	30	30
Imported Groundwater - McMullen Valley	0	0	0	38	38	38	38	38	38	38	38
Existing Underground Storage Credit Recovery (limited term)	0	0	0	0	0	10	10	10	0	0	0
CAP - ASLD- Phoenix Volume (M&I)	0	10	11	11	11	10	10	10	10	10	10
Reclaimed Water (for direct-delivery/recovery/exchange)	0	7	18	31	39	47	52	57	59	59	60
CAP - NIA Reallocation (NIA) ****	0	0	0	0	0	0	0	0	0	0	0
Total Future Supplies	0	17	59	110	117	136	141	146	137	138	139
DEMAND MANAGEMENT											
Net water savings (assuming aggressive conservation)*****	0	1	10	27	31	35	39	44	45	45	45
DROUGHT RESPONSE REQUIRED (ADDITIONAL DEMAND MANAGEMENT OR SUPPLEMENTAL SUPPLIES)											
Current Water Use Rate Scenario	0	0	0	0	2	33	70	111	93	100	102
Aggressive Conservation Scenario	0	0	0	0	0	0	30	67	49	55	57
CURRENT SUPPLIES AND EXISTING CUSTOMERS											
Current supplies less existing customer demand	59	56	86	95	94	94	94	94	129	128	128
Assume 10 percent conservation from existing customers	-	91	121	130	130	130	129	129	164	163	163

* Available supply is limited by demand (excess supply cannot be used off project)

** Status changes from agricultural priority (non-firm) to M&I priority (firm) in 2044

*** Current capacity allows for 44,000 af/yr during periods of drought. Normal year pumpage assumed at 15,000 af (and is well within Assured Water Supply groundwater allowance)

**** Reallocation volumes not yet determined

***** Does not include water savings on-project when available SRP supplies exceed demand (the saved water remains in SRP reservoirs)

APPENDIX B
WATER BUDGET AND PROJECTION DETAILS

SCENARIO E: Severe Shortage, General Plan Growth

(Figures expressed in 1,000 acre-feet)

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055
COLORADO RIVER AVAILABILITY											
Normal Year AZ Allocation	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
Shortage Reduction Volume for AZ	900	900	900	900	900	900	900	900	900	900	900
Net Colorado R.Supply Available to AZ	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900
Pre-1968 Colorado River Supply (Priority 1, 2 and 3)	1,204	1,244	1,248	1,253	1,258	1,263	1,268	1,273	1,278	1,284	1,284
Priority 4 Colorado River Supply Available	696	656	652	647	642	637	632	627	622	616	616
P4 River Demand (consumptive use)	81	105	108	111	114	116	117	119	120	122	122
CAP P4 Demand before loss	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436
CAP P4 Supply after loss	588	540	535	529	524	518	513	508	502	497	497
New Mexico Demand	0	0	0	0	18	18	18	18	18	18	18
Priority 4 Colorado River water available to CAP	588	540	535	529	506	500	495	490	484	479	479
M&I CAP Demand	479	602	639	639	639	639	639	639	686	686	686
CAP - M&I Supply	479	343	340	337	322	318	315	312	308	305	305
CAP - M&I Shortage	0	259	299	302	317	320	324	327	378	382	382
Indian CAP Demand	62	199	314	336	340	343	343	343	343	343	343
P4 Indian Supply	62	196	194	193	184	182	180	178	176	174	174
CAP - Indian Supply (Adjusted)	62	196	194	193	184	182	180	178	176	174	174
CAP - Indian Shortage	0	2	120	143	156	161	163	165	167	169	169
NIA CAP Demand	64	96	104	162	216	360	365	365	317	317	317
CAP - NIA Supply	47	0	0	0	0	0	0	0	0	0	0
CAP - NIA Shortage	18	96	104	162	216	360	365	365	317	317	317
Excess CAP	0	0	0	0	0	0	0	0	0	0	0
ON-PROJECT PROJECTIONS WITH CURRENT SUPPLIES											
Water Right Acres (1,000)	78	85	90	94	94	94	94	94	94	94	94
Stored and Developed Available	234	170	180	188	188	188	188	188	188	188	188
Normal Flow Available	73	54	58	60	60	60	60	60	60	60	60
Penninsula-Horowitz Available	0	2	3	3	3	3	3	3	3	3	3
Total SRP Available	307	226	240	251	251	251	251	251	251	251	251
Groundwater (Phoenix wells)	0	0	0	0	0	0	0	0	0	0	0
SUPPLY - On-Project*	179	141	150	157	157	157	157	157	157	157	157
DEMAND - On-Project	179	198	206	214	218	222	223	224	224	224	224
On-Project Surplus/(Deficit)	**0**	(57)	(56)	(57)	(61)	(65)	(66)	(67)	(67)	(67)	(68)
OFF-PROJECT PROJECTIONS WITH CURRENT SUPPLIES											
CAP - Colorado River Exchange (Pre-1968)	5	5	5	5	4	4	4	4	5	5	5
CAP - Existing Subcontract (M&I)	114	61	61	60	57	57	56	56	51	51	51
CAP - GRIC Settlement Reallocation (M&I)	0	4	4	4	4	4	4	4	4	4	4
CAP - AWBA Shortage Insurance (limited term)	0	24	24	24	24	24	24	24	32	32	32
CAP - Fort McDowell Settlement (Indian)	4	3	3	3	3	3	3	3	3	3	3
CAP - SRPMIC Lease (Indian)	3	2	2	2	2	2	2	2	2	2	2
CAP - GRIC Indian Lease (Indian)	0	8	8	8	7	7	7	7	7	7	7
CAP - RWCD Makeup Water (NIA)	1	0	0	0	0	0	0	0	0	0	0
CAP - Hohokam ID Buyout (NIA/M&I)**	36	0	0	0	0	0	0	0	16	16	16
SRP - Horseshoe Dam Gatewater	19	0	0	0	0	0	0	0	0	0	0
SRP - Roosevelt Dam New Conservation Space	29	0	0	0	0	0	0	0	0	0	0
Reclaimed Water - RID Exchange	20	0	0	0	0	0	0	0	0	0	0
Reclaimed Water - Direct	2	5	5	5	5	5	5	5	5	5	5
Groundwater***	0	44	44	44	44	44	44	44	44	44	44
SUPPLY - Off Project	233	156	156	155	151	151	150	149	168	167	167
DEMAND - Off-Project	173	201	226	255	274	294	307	321	324	326	329
Off-Project Surplus/(Deficit)	**59**	(45)	(71)	(100)	(122)	(143)	(157)	(172)	(156)	(159)	(162)
COMBINED ON AND OFF PROJECT SUMMARY											
Total Current Supplies	**412**	**297**	**306**	**312**	**308**	**307**	**307**	**306**	**325**	**324**	**324**
Projected Demand	**352**	**399**	**433**	**469**	**491**	**516**	**530**	**546**	**548**	**550**	**553**
Surplus/(Deficit) - With Current Sources	**59**	(102)	(127)	(157)	(183)	(208)	(223)	(239)	(223)	(227)	(229)
FUTURE SUPPLY OPTIONS (DRY YEAR AND GROWTH-RELATED)											
Additional Safe-Yield Groundwater (limited term)	0	0	30	30	30	30	30	30	30	30	30
Imported Groundwater - McMullen Valley	0	0	0	38	38	38	38	38	38	38	38
Existing Underground Storage Credit Recovery (limited term)	0	10	10	10	10	10	10	10	10	10	10
CAP - ASLD- Phoenix Volume (M&I)	0	5	6	6	6	6	6	6	6	6	6
Reclaimed Water (for direct-delivery/recovery/exchange)	0	7	18	31	39	47	52	57	59	59	60
CAP - NIA Reallocation (NIA) ****	0	0	0	0	0	0	0	0	0	0	0
Total Future Supplies	**0**	**22**	**65**	**115**	**123**	**131**	**136**	**141**	**142**	**143**	**144**
DEMAND MANAGEMENT											
Net water savings (assuming aggressive conservation)*****	0	22	31	42	48	52	56	60	60	61	60
DROUGHT RESPONSE REQUIRED (ADDITIONAL DEMAND MANAGEMENT OR SUPPLEMENTAL SUPPLIES)											
Current Water Use Rate Scenario	0	80	62	42	60	77	87	98	81	83	85
Aggressive Conservation Scenario	0	58	31	0	13	25	31	38	20	23	25
CURRENT SUPPLIES AND EXISTING CUSTOMERS											
Current supplies less existing customer demand	59	(55)	(47)	(41)	(44)	(45)	(46)	(47)	(28)	(29)	(29)
Assume 10 percent conservation from existing customers	-	(20)	(12)	(6)	(9)	(10)	(11)	(11)	7	7	7

* Available supply is limited by demand (excess supply cannot be used off project)

** Status changes from agricultural priority (non-firm) to M&I priority (firm) in 2044

*** Current capacity allows for 44,000 af/yr during periods of drought. Normal year pumpage assumed at 15,000 af (and is well within Assured Water Supply groundwater allowance)

**** Reallocation volumes not yet determined

***** Does not include water savings on-project when available SRP supplies exceed demand (the saved water remains in SRP reservoirs)

APPENDIX B
WATER BUDGET AND PROJECTION DETAILS

SCENARIO F: Severe Shortage, High Density Growth

(Figures expressed in 1,000 acre-feet)

	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050	2055
COLORADO RIVER AVAILABILITY											
Normal Year AZ Allocation	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800	2,800
Shortage Reduction Volume for AZ	900	900	900	900	900	900	900	900	900	900	900
Net Colorado R.Supply Available to AZ	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900	1,900
Pre-1968 Colorado River Supply (Priority 1, 2 and 3)	1,204	1,244	1,248	1,253	1,258	1,263	1,268	1,273	1,278	1,284	1,284
Priority 4 Colorado River Supply Available	696	656	652	647	642	637	632	627	622	616	616
P4 River Demand (consumptive use)	81	105	108	111	114	116	117	119	120	122	122
CAP P4 Demand before loss	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436	1,436
CAP P4 Supply after loss	588	540	535	529	524	518	513	508	502	497	497
New Mexico Demand	0	0	0	0	18	18	18	18	18	18	18
Priority 4 Colorado River water available to CAP	588	540	535	529	506	500	495	490	484	479	479
M&I CAP Demand	479	602	639	639	639	639	639	639	686	686	686
CAP - M&I Supply	479	343	340	337	322	318	315	312	308	305	305
CAP - M&I Shortage	0	259	299	302	317	320	324	327	378	382	382
Indian CAP Demand	62	199	314	336	340	343	343	343	343	343	343
P4 Indian Supply	62	196	194	193	184	182	180	178	176	174	174
CAP - Indian Supply (Adjusted)	62	196	194	193	184	182	180	178	176	174	174
CAP - Indian Shortage	0	2	120	143	156	161	163	165	167	169	169
NIA CAP Demand	64	96	104	162	216	360	365	365	317	317	317
CAP - NIA Supply	47	0	0	0	0	0	0	0	0	0	0
CAP - NIA Shortage	18	96	104	162	216	360	365	365	317	317	317
Excess CAP	0	0	0	0	0	0	0	0	0	0	0
ON-PROJECT PROJECTIONS WITH CURRENT SUPPLIES											
Water Right Acres (1,000)	78	85	90	94	94	94	94	94	94	94	94
Stored and Developed Available	234	170	180	188	188	188	188	188	188	188	188
Normal Flow Available	73	54	58	60	60	60	60	60	60	60	60
Penninsula-Horowitz Available	0	2	3	3	3	3	3	3	3	3	3
Total SRP Available	307	226	240	251	251	251	251	251	251	251	251
Groundwater (Phoenix wells)	0	0	0	0	0	0	0	0	0	0	0
SUPPLY - On-Project*	179	141	150	157	157	157	157	157	157	157	157
DEMAND - On-Project	179	212	241	278	301	327	350	374	378	382	382
On-Project Surplus/(Deficit)	**0**	(72)	(91)	(122)	(144)	(170)	(193)	(217)	(222)	(225)	(225)
OFF-PROJECT PROJECTIONS WITH CURRENT SUPPLIES											
CAP - Colorado River Exchange (Pre-1968)	5	5	5	5	4	4	4	4	5	5	5
CAP - Existing Subcontract (M&I)	114	61	61	60	57	57	56	56	51	51	51
CAP - GRIC Settlement Reallocation (M&I)	0	4	4	4	4	4	4	4	4	4	4
CAP - AWBA Shortage Insurance (limited term)	0	24	24	24	24	24	24	24	32	32	32
CAP - Fort McDowell Settlement (Indian)	4	3	3	3	3	3	3	3	3	3	3
CAP - SRPMIC Lease (Indian)	3	2	2	2	2	2	2	2	2	2	2
CAP - GRIC Indian Lease (Indian)	0	8	8	8	7	7	7	7	7	7	7
CAP - RWCD Makeup Water (NIA)	1	0	0	0	0	0	0	0	0	0	0
CAP - Hohokam ID Buyout (NIA/M&I)**	36	0	0	0	0	0	0	0	16	16	16
SRP - Horseshoe Dam Gatewater	19	0	0	0	0	0	0	0	0	0	0
SRP - Roosevelt Dam New Conservation Space	29	0	0	0	0	0	0	0	0	0	0
Reclaimed Water - RID Exchange	20	0	0	0	0	0	0	0	0	0	0
Reclaimed Water - Direct	2	5	5	5	5	5	5	5	5	5	5
Groundwater***	0	44	44	44	44	44	44	44	44	44	44
SUPPLY - Off Project	233	156	156	155	151	151	150	149	168	167	167
DEMAND - Off-Project	173	196	219	245	265	288	308	329	333	336	339
Off-Project Surplus/(Deficit)	**59**	(40)	(64)	(90)	(114)	(138)	(158)	(180)	(165)	(170)	(172)
COMBINED ON AND OFF PROJECT SUMMARY											
Total Current Supplies	412	297	306	312	308	307	307	306	325	324	324
Projected Demand	352	408	460	523	567	615	657	703	711	718	721
Surplus/(Deficit) - With Current Sources	**59**	(111)	(155)	(212)	(258)	(308)	(351)	(397)	(387)	(395)	(397)
FUTURE SUPPLY OPTIONS (DRY YEAR AND GROWTH-RELATED)											
Additional Safe-Yield Groundwater (limited term)	0	0	30	30	30	30	30	30	30	30	30
Imported Groundwater - McMullen Valley	0	0	0	38	38	38	38	38	38	38	38
Existing Underground Storage Credit Recovery (limited term)	0	10	10	10	10	10	10	10	10	10	10
CAP - ASLD- Phoenix Volume (M&I)	0	5	6	6	6	6	6	6	6	6	6
Reclaimed Water (for direct-delivery/recovery/exchange)	0	10	28	50	65	82	97	113	116	118	119
CAP - NIA Reallocation (NIA) ****	0	0	0	0	0	0	0	0	0	0	0
Total Future Supplies	0	25	74	134	149	166	181	197	200	202	203
DEMAND MANAGEMENT											
Net water savings (assuming aggressive conservation)*****	0	12	19	27	31	35	39	44	45	45	45
DROUGHT RESPONSE REQUIRED (ADDITIONAL DEMAND MANAGEMENT OR SUPPLEMENTAL SUPPLIES)											
Current Water Use Rate Scenario	0	86	80	77	109	142	170	201	187	193	194
Aggressive Conservation Scenario	0	74	62	51	78	106	130	156	142	148	149
CURRENT SUPPLIES AND EXISTING CUSTOMERS											
Current supplies less existing customer demand	59	(55)	(47)	(41)	(44)	(45)	(46)	(47)	(28)	(29)	(29)
Assume 10 percent conservation from existing customers	-	(20)	(12)	(6)	(9)	(10)	(11)	(11)	7	7	7

* Available supply is limited by demand (excess supply cannot be used off project)

** Status changes from agricultural priority (non-firm) to M&I priority (firm) in 2044

*** Current capacity allows for 44,000 af/yr during periods of drought. Normal year pumpage assumed at 15,000 af (and is well within Assured Water Supply groundwater allowance)

**** Reallocation volumes not yet determined

***** Does not include water savings on-project when available SRP supplies exceed demand (the saved water remains in SRP reservoirs)

APPENDIX C
ACRONYMS USED IN THIS DOCUMENT

ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Water Department of Water Resources
AF	Acre feet (1 AF = 325851 gallons)
AMA	Active Management Area
ASR	Aquifer Storage and Recovery
ASLD	Arizona State Land Department
AWBA	Arizona Water Banking Authority
AWS	Assured Water Supply
BIC	Buckeye Irrigation Company
CAGRD	Central Arizona Groundwater Replenishment District
CAP	Central Arizona Project
CASS	Central Arizona Salinity Study
CCWRP	Cave Creek Water Reclamation Plant
CRBSCF	Colorado River Basin Salinity Control Forum
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FONSI	Finding of No Significant Impact
GPCD	Gallons Per-Capita Per Day
GRIC	Gila River Indian Community
GRUSP	Granite Reef Underground Storage Project
GSF	Groundwater Savings Facility
HCP	Habitat Conservation Plan
I-17	Interstate 17
M&I	Municipal and Industrial
MAG	Maricopa Association of Governments
mg/L	milligrams per liter
mgd	million gallons per day
NCS	New Conservation Space
NEPA	National Environmental Policy Act
NPL	National Priorities List
OU1	Operable Unit 1
OU2	Operable Unit 2
OU3	Operable Unit 3
PCE	Tetrachloroethane
PPB	Parts Per Billion
RID	Roosevelt Irrigation District
RWCD	Roosevelt Water Conservation District
SDWA	Safe Drinking Water Act
SROG	Sub-Regional Operating Group
SRP	Salt River Project
SRPMIC	Salt River Pima Maricopa Indian Community
TCA	Trichloroethane
TCE	Trichloroethylene
TDS	Total Dissolved Solids
USBR	United States Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
VOC	Volatile Organic Compounds
WESTCAPS	- West Valley Coalition of CAP Subcontractors
WET	Water Education for Teachers
WQARF	Water Quality Assurance Revolving Fund
WWTP	Wastewater Treatment Plant

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